February 28, 1911.

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POWER

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RHOADS TANNATE BELT

IT COSTS LESS

TANNATE TRADE MARK REG. IN U.S. PAT. OFF.

PER DAY

Three Times The Life Of An Oak Belt For 60% Of The Cost Per Day

¶ On a planer head dressing hard wood, a Tannate Belt lasted 128 days while an oak belt lasted only 42 days. The oak cost nearly 45 cents per day; the Tannate only about 26 cents.

¶ The machine pictured above is in another planing mill which has long used Tannate with saving and satisfaction. ¶ The flexibility and cling of Tannate transmit the power with minimum waste on short turns, while its toughness far outlives oak belts. ¶ Besides these special qualities, Tannate Belts have the thorough lubrication, permanent stretch, and uniform strength that characterize all Rhoads Belts. ¶ They give you a larger output per year, because of fewer stops for take-ups and repairs. They cost less per year because they last longer. ¶ *Let your dealer supply your next needs with Tannate.*

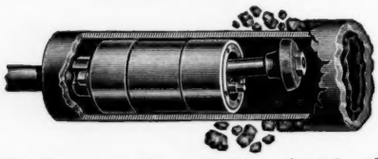
If he hasn't it, write us.

J. E. Rhoads & Sons,

Philadelphia: 12 N. Third St. New York: 40 Fulton St. Chicago: 243 E. Randolph St.

Factory and Tannery: Wilmington, Del.

The Dean removing scale from the tube of a water tube boiler



The Dean removing scale from the tube of a return tubular boiler

Let Us Loan You A Dean For A Thorough Trial In One Boiler

We want you to find out what condition your tubes are in—they may be a good deal dirtier than you think.

Then we want you to see that you can do your boiler cleaning in less time, with greater ease and at smaller cost with a Dean than you can with anything else.

The Dean Boiler Tube Cleaner

goes where no inspector can—makes no mistakes—tells the truth—never leaves you in doubt about its effectiveness.

It leaves the tubes through which it passes as clean as gun barrels.

It cleans 10 to 30 tubes an hour and never injures a sound tube.

The Dean may be used in Fire Tube and Water Tube boilers.

It's the logical way of removing scale and it has made good wherever it has gone.

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The coming engineer—the man who will command the highest wages and be in the greatest demand—MUST BE A CO_2 ENGINEER.

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Flue gas analysis isn't hard; any engineer can learn it.

And it isn't mere theory; lots of up-to-date engineers are getting, through flue gas analysis, results that can be measured in the terms of dollars and cents.

Why not YOU?

Here is a *FLUE GAS ANALYSIS INSTRUMENT* that is simple, easily operated, accurate; that has been tested out again and again and made good every time; that is cheap enough to be within the reach of any man's pocket book.

It determines CO_2, O and CO and tells you what to do to increase your furnace efficiency.

Write for catalogue.

POWER

NEW YORK, FEBRUARY 28, 1911

AN ancient allegory deals with certain six blind men who went once to "view" an elephant. After the manner of the blind, their "viewing" was done through the sense of touch.

It so happened that each came in contact with a different part of the pachyderm; one touched its trunk, one took hold of a tusk, one felt an ear, another touched a foreleg, another felt its side and the sixth caught hold of the elephant's tail.

When asked to give his "views" on elephants, the first man intimated that an elephant was long and round in form and coiled up toward the end, very similar to a huge snake.

The second man went on record to the effect that elephants were much like spears.

The third thought that an elephant was much like a fan in physical characteristics.

An interview with the fourth man brought out the interesting information that an elephant was not unlike a tree trunk, being thick and strong and planted firmly on the ground.

The fifth man was positive in his belief that an elephant resembled nothing more than the side of a barn, being flat and broad.

While the sixth man did not wish to contradict anything which his companions had said, he felt justified in maintaining that an elephant was merely thin and long, just like a piece of ordinary rope.

Thus it was that the term "nature faker" came into vogue, although none of these blind men really was one, for the term faker implies deliberate deception while these men were entirely sincere in their misstatements.

* * *

The fable, a synopsis of which has just been given, was designed to show how easily a wrong opinion may be formed if limited observations are used as a basis.

All of us form wrong opinions; sometimes, because we form them too hastily, before all of the facts are in; sometimes, because the question is too large for us to view the whole of it at once and, like the blind men, we are led astray by our limited observations.

The giant says that the wall is easy to scale, and proves it by getting over in "jig time." The dwarf complains that it is too high and does not even attempt to climb it.

Whether we are mental giants or dwarfs depends a lot upon ourselves.

How easy it is to withhold judgment until we are positive that all the facts are in—that we have "viewed" the "elephant" from all sides! How easy, to measure our "wall" by true standards, not by self-made, dwarfish units of measurement!

First, get the right point of view and, second, size things up at their true values.

Let's not underestimate our faults and overestimate our hardships.

Additions to Hartford Power Plant

By H. R. Callaway

The Dutch Point station, which carries the greater part of the lighting and power load for Hartford and the surrounding districts, has recently been equipped with two additional 1250-horsepower Bigelow-Hornsby boilers. These are served by the largest automatic stokers ever built.

The Dutch Point station of the Hartford Electric Light Company, at Hartford, Conn., has been a gradual growth from a small auxiliary to the water-power installations of this company to its present status as the main generating station of the Hartford system. When the company first began business its current output was the product of two small hydroelectric developments having a total output of not more than 2400 kilowatts. As the load became greater it became necessary to build a small steam station to serve as an auxiliary in the time of low water, and a location on what is known as Dutch point, on the Connecticut river, was chosen as the site. A small creek runs into the river at this spot, and the station is located on the point of land between the creek and the river, thus making it a handy site for the delivery of coal and other supplies.

As the load on the company's system increased, the development has been along the line of additional steam power, so that now the water powers furnish a rather insignificant proportion of the total electricity. So rapidly has the sale of electricity increased that the Dutch Point station has been added to several times, and the company has just recently completed the latest of these additions to the equipment.

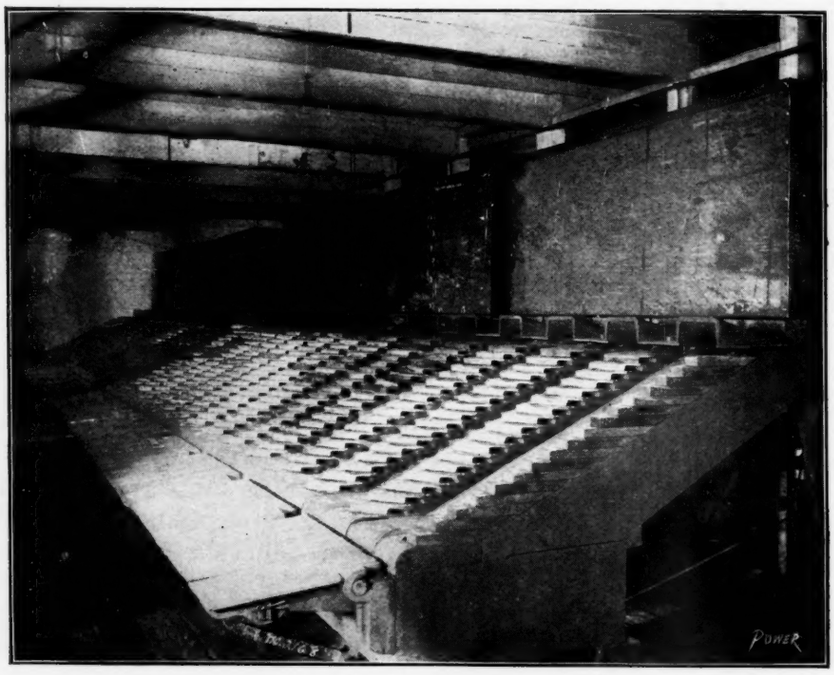


FIG. 1. STOKER ASSEMBLED IN SHOP

The power-house building, including the recent additions, is about 250 feet long by 135 feet wide. It is of steel frame and brick construction throughout, with a brick dividing wall running lengthwise of the building and separating the boiler room from the turbine room. On the side of the building opposite the boiler house is an extra bay slightly lower than the rest of the building which houses the switchboard and the gallery containing the electrical equipment and the circulating pumps for the condensers.

The original boiler-house equipment consisted of six 550-horsepower Aultman-Taylor boilers. These are arranged in a single row with the horizontal firing aisle next to the building wall. Later it was decided to add 2500 boiler horsepower, and two 1250-horsepower Bigelow-Hornsby boilers were installed, these being set beyond the Aultman-Taylor boilers and transversely with the boiler house. The latest addition to the boiler equipment has been two more 1250-horsepower Bigelow-Hornsby boilers placed in an addition built onto the end of the boiler house next to that part occupied by the transverse boilers. The unusual size of the four latest additions to the boiler room is one of the notable features of this station, and not only are the boilers themselves of unprecedented size, but they are equipped with the largest automatic stokers ever built. These are fourteen retort Taylor gravity underfeed stokers, shown in Fig. 1. The first installation of these mammoth stokers was on the two latest of the Bigelow-Hornsby boilers. Afterward it was decided to change over the two original 1250-horsepower boilers from hand firing to automatic stoker firing, and these are now being equipped with Taylor stokers. The main reasons for using such large boiler units at this station were concentration of power, economy of floor space and increased economy in operation due to a smaller amount of radiation.

The Bigelow-Hornsby boilers which are shown in Fig. 2 measure 27 feet 6 inches across the front and stand 21 feet 6½ inches from the floor line to the center of the steam drum. The latter is 4 feet in diameter and extends the entire width of the top of the setting. This drum connects with forty sections of 3¼-inch water tubes, 21 tubes to a section, or in all 840 tubes, each section of water tubes terminating at either end in a cylindrical header. The front sections are inclined at a steep angle, while the rear sections are vertical. In this type of boiler the depth of the furnace is necessarily somewhat limited; therefore the extreme width of grate and a high rate of combustion are depended upon to develop the rated horsepower. All the boilers in the station are equipped with Foster superheaters. Three 10-foot steel stacks serve the various batteries, two of these discharging the gases from the Aultman-Taylor boilers and the two oldest Bigelow-Hornsby boilers, and the third, a new 50-foot stack, serving the two latest units. The stokers operate on about 4 inches draft, but as yet there is no information available as to the performance of these huge units. Tests, however, will be made before long, the results of which are awaited with interest, owing to their unusual size.

One of the principal reasons for the installation of automatic stokers in this station was economy in labor, 2500 horsepower of boilers being operated by three men per day of 24 hours. When this same battery of boilers was operated with hand firing it took 12 men per day for the same capacity.

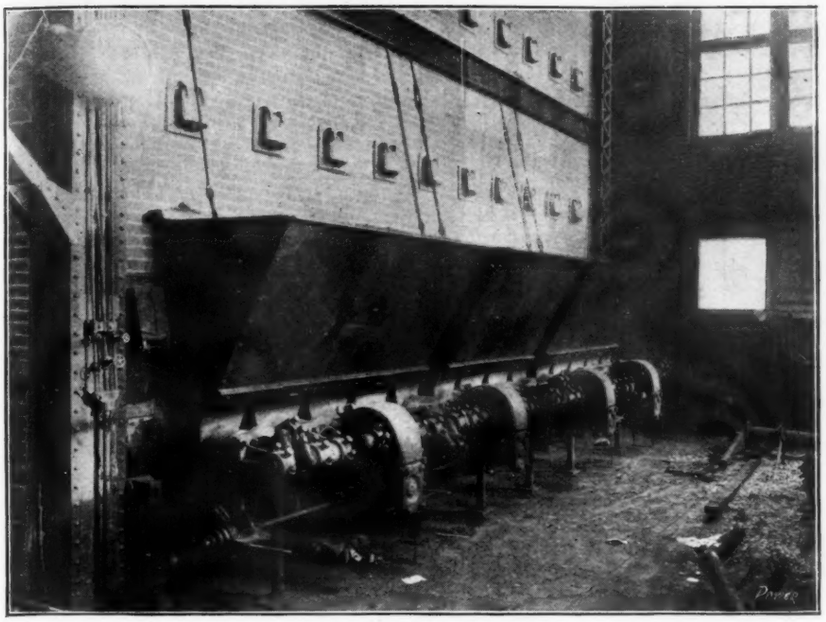


FIG. 2. FRONT OF BOILERS SHOWING STOKER

There are in all six main units: one 3000-kilowatt, one 2000-kilowatt and two 1000-kilowatt Westinghouse turbo-generators and two 4000-kilowatt General Electric horizontal turbo-generators, the latter being the latest additions. The six machines all operate in parallel and generate two-phase, 60-cycle current at 2400 volts.

The turbines receive steam at 150 pounds pressure and 100 degrees superheat from a single 12-inch main running alongside the boiler-room wall and behind the batteries. The leads taken off to the various turbines are of 6-inch, 8-inch and 10-inch pipe; 6-inch to the two small units; 8-inch to the 2000-kilowatt Westinghouse turbine and to the new General Electric machines; and a 10-inch to the 3000-kilowatt machine.

Situated in the basement directly below their respective turbines are the condensers and their auxiliaries. The largest of the Westinghouse turbines exhausts into two condensers operated in parallel, each containing 6000 square feet of surface. By a suitable arrangement of valves this machine can operate singly on either condenser if required. Although the 12,000 square feet of surface available for this machine is much larger than is necessary, this arrangement enabled the company to make use of an old 6000-square foot condenser instead of scrapping it and buying a new one of 10,000 square feet. The two 1000-kilowatt turbines are served by a single 6000 square foot condenser and the 2000-kilowatt machine by one of 8000 square feet. The four Westinghouse units are all provided with similar circulating-pump installations, each pump being driven through a long vertical shaft by an induction motor situated in a gallery alongside the switchboard. Each pump is provided with a separate intake from the river, but the discharges of all are joined into one pipe line which ends at a point somewhat downstream from the intakes.

Very little condenser-tube trouble has developed at this station, due probably to the fact that there are few acids in the water of the Connecticut river. Instead of the pitting so often found in condenser tubes of large power stations, the main trouble here seems to be the wear at the ends of the tubes due to expansion and contraction in the heating and cooling of the condenser. Naturally this trouble is not as serious as is the case of poor water, the tubes merely becoming loose at the heads. A rather ingenious method is used for saving the tubes worn in this manner, by cutting them off just inside the condenser heads and inserting a short length of smaller tubing, which is extended just inside the cutoff ends and then sweated on. This method results in cutting down the area somewhat, which, however, matters very little in this particular case because the condensers are altogether too large for the turbines.

Each of the two new General Electric turbo-alternators is equipped with a 10-000-square foot condenser having 1-inch tubes. The auxiliaries for these machines are rather unique and exceedingly compact. They consist of a centrifugal pump for circulating water, and another for the hotwell water placed on the same shaft, both pumps being driven direct by a steam turbine; these are shown in Fig. 3. The dry-air pumps for all the condensers are set on the turbine-room floor between the machines, and the vacuum maintained is unusually high, the average during the winter being 28.75 inches, based on a 30-inch barometer.

As already stated, the coal is usually received by water, it being brought up the river in barges and unloaded at the company's dock beside the power station. In addition to the facilities for receiving

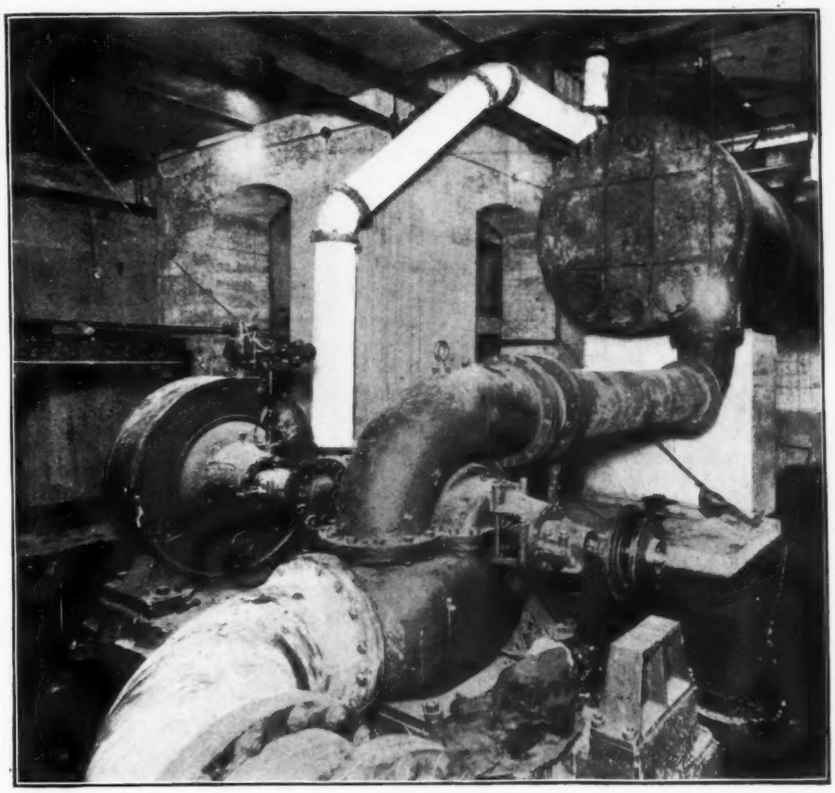


FIG. 3. CONDENSING OUTFIT

coal and other supplies by water, a spur track runs alongside the station on the boiler-room side. This is utilized for obtaining coal by rail during the winter months when the river is frozen and a sufficient supply has not been stored in the fall, although the 18,000-ton capacity of the storage bins usually proves adequate for this period. The approximate yearly coal consumption is 40,000 long tons.

The system of handling the coal is unusual. In addition to the spur track, already mentioned, which runs on the boiler-room side of the station, another spur runs on the river side along the unloading piers. Two derricks mounted on railroad trucks are used for unloading and loading the coal cars on these tracks. One derrick hoists coal from the barges and deposits it into the coal cars which are then shunted around onto the other track, and there unloaded into bins from which the coal falls by gravity to the boiler-room floor. In the case of the new stoker-fired boilers the coal goes from the bins into the hopper over the firing aisle, from which it is fed through chutes into the retorts of the stokers. Where the coal is brought by rail the cars are simply run in on the spur next to the storage bins and unloaded by means of the derrick hoists. It is said that 3 cents per long ton covers all unloading charges for coal. The hand-fired boilers burn a mixture of 75 per cent. No. 3 buckwheat and 25 per cent. bituminous coal. This mixture is the result of a large number of experiments on the most efficient and economical coal for use under the hand-fired boilers, and marks the point where the pounds of steam per unit cost is a maximum.

The Taylor stokers are supplied entirely with soft coal averaging about 14,600 B.t.u. per pound. The buckwheat averages 11,400 B.t.u. per pound. Although the mixture has proved to be the most economical fuel for average conditions on the hand-fired boilers, it has been found that under peak loads it is impossible to get sufficient capacity out of the boilers. Accordingly at the time of heaviest loads it is customary to burn straight soft coal on the hand-fired boilers as well as on the stokers. In the case of the former, this practice gives rise to considerable smoke and poor efficiency, which was another reason for the installation of the mechanical stokers under the new boilers.

The present system is to carry the steady load of the station on the stoker-fired boilers and handle the peak loads with the hand-fired boilers.

The ashes are dumped from hoppers under the boilers into ash cars in the basement. These discharge into a bucket hoist at one end of the boiler house, which dumps the ashes into carts. The ashes are then carted away by contractors who take all the ashes from the station without charge, so that the ash-disposal problem is very simple.

The station contains no fire pumps whatever; the construction being practically fireproof throughout and the coal-storage bins being outside the station walls, the chances of fire are exceedingly small. Located as it is on an isolated point between two bodies of water it would be impossible for a fire in the station to do harm outside the premises.

Buckwheat No. 3, delivered by water,

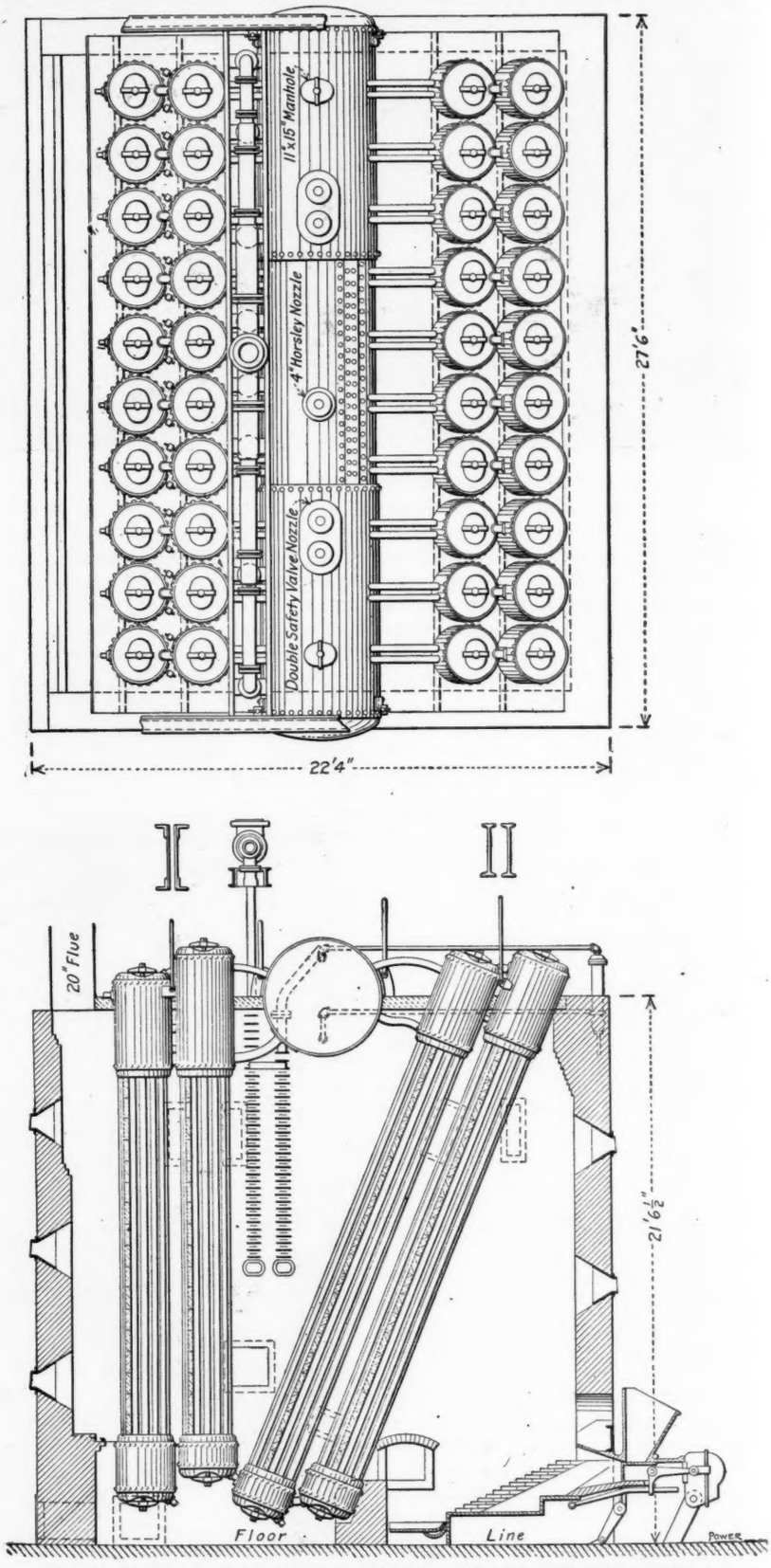


FIG. 4. SECTIONAL ELEVATION AND PLAN OF BIGELOW-HORNSBY BOILER

costs $2.05 per ton; by rail, $2.72. The bituminous coal costs $3.35 and $3.65 respectively.

The electrical distribution is divided up into two separate systems. For the city proper the current is not transformed but is transmitted at the generator voltage of 2400 to two substations, where it is stepped down to 220 volts and changed to direct current by means of rotary converters.

The lighting distribution from these two substations is on the Edison three-wire system, 220 volts outside and 110 volts between the outside and the grounded neutral. In the case of large power consumers, such as mills and factories, separate feeders go direct from the power house to transformers located on poles at the mill end of the feeders; this current is alternating.

There is a second system of distribution in use for the outlying districts; transformers located in the basement of the station step up the voltage from 2400 volts two-phase to 11,000 volts three-phase. In this system there are no converters, alternating current being distributed and stepped down by pole transformers.

The winter load on the system averages 140,000 kilowatt-hours per day and the load factor is unusually high for a lighting installation, approximating 65 per cent. Because of the large number of induction motors operating during the day in the various factories, the power factor during the day time is only 85 per cent. As soon as the motor load goes off in the evening the power factor rises to 95 per cent. It is understood, however, that rotary condensers are to be installed in order to counterbalance the lagging effect of the induction motors and to bring up the load factor during the day to somewhat near unity. It would not be necessary to operate them during the night.

The designing engineers of this plant, who also had charge of the erection, are Westinghouse, Church, Kerr & Co., of New York City.

Making, Use and Care of Belting

By Chas. A. Schieren, Jr.*

The tanning of hides for belt leather by the old, long-time, oak-bark process and the operations in making belts.

Belt specifications fair to both buyer and seller, and belting factors that have been tested by long experience. How to get maximum belt service per dollar of investment.

*Treasurer, Charles A. Schieren Company.

With the bark and the hides at hand the process of tanning to produce leather for belting may be taken up.

The hides are first soaked in pure spring water until all the dirt is thoroughly washed out of them. They are then placed in a vat of weak lime water, which is gradually strengthened until the sixth day, when the hair has been loosened sufficiently to allow the skin to be laid on a beam and the hair scraped off with a blunt knife.

The bare hides are then placed in an alkaline solution called the "bate," for the purpose of removing the lime which may have remained from the previous bath; this liming and "bating," done in a building known as the "beam house" or "lime house," is a very important step in the making of good, solid belt leather.

Cleansed from hair, flesh and lime, the hides are taken from the "bate" to the "handlers," where they receive their first bath of weak tanning liquor.

Preparing the Tanning Liquor

This liquor is prepared from oak bark. Ten years ago this bark was ground in something like an overgrown coffee mill, but our tannery has been equipped for five years past with an improved crushing machine which does the work quicker and more effectively, and as the crushed bark leaves this machine it is blown by means of a rotary fan through large metal pipes to the leach tubs.

These are 12 feet in diameter, eight feet deep, and hold fully eight tons of ground bark.

To this ground bark, water is added by means of rotary brass sprinklers, and filtering through the mass, takes up and carries downward the tannic acid.

There is a false bottom in each leaching tub, and the liquor is collected beneath it and pumped away to the storing and supply tanks for use when needed. It is from these tanks that the liquor is drawn for the handler vats in which the hides are put after the "liming" and "bating."

Tanning

The hides are placed in the handler vats across sticks side by side, packed as closely as possible, and are left here for about 10 or 12 days, during which the hide swells, opening the pores and increasing both in thickness and firmness.

When the hides are taken from these vats the bellies and heads are trimmed off and tanned separately for shoe purposes. The butt portions intended for belting are then stowed in vats called "lay-aways." Here they are laid flat, one on top of the other, about a hundred in each vat; loose bark is spread between the layers, and they are covered with strong tanning liquor.

Hides intended for belting are given five successive layers or treatment of bark. The first layer remains 10 days, and the process is graded up to 40 days for the last layer.

In this way oak-tanned belt leather is submitted to a tanning which takes 120 days for the attainment of the best results.

Drying and Finishing the Belt Centers

When the hides have thus been thoroughly tanned they are taken from the vats, washed, so as to remove every particle of tan bark, and then oiled on the grain side, hung up to dry in a darkened loft, where they are kept at an even temperature with very little heat, and gain a beautiful clear russet color. The leather, as such, is now completed, and each hide is cut into widths according to its grade and weight.

The bellies, shoulders and all flabby or imperfect parts are thrown out for shoe purposes, and the central portion or heart of the hide is reserved for belting.

This solid leather is carefully shaved on the flesh side in huge machines, operating somewhat on the principle of a milling machine, and is then scoured by other machinery. The object of this is to open up the pores for the reception of the stuffing of cod oil and pure beef tallow by which the leather is preserved and made suitable for the transmission of power.

Many hours are devoted to this stuffing, and the thoroughness with which it is done lends to belting one of its most prominent features—long life. When the stuffing is accomplished the leather is smoothed and stretched so that the fibers will be made uniform.

Nothing now remains to be done at the tanneries but to allow the leather to dry, brush it off, pack it in bundles and ship it to the belt factory.

The capacity of the Dixie Tannery, of Bristol, Tennessee, owned by the Charles A. Schieren Company, is 100,000 hides a year, and its equipment is used solely for tanning and finishing prime oak leather for belting.

The leather, centers and sides, when they reach the belting factory, are from 4⅓ feet to 4½ feet long. At the tan-

nery, after the leather is taken out of the vats, and before the currying process, the shoulders are removed from all of the hides, and each hide is measured four feet from the butt end of the tail to the shoulder, and the shoulder cut straight across so that no piece of shoulder or flanky leather is left on the hide.

After the severe stretching which these pieces undergo during the currying process and in the stretching frames the pieces elongate from four inches to six inches, making each piece four feet to four feet six inches in length, and all of the pieces solid leather.

Operations in Making a Leather Belt

The first process at the belting factory is to select the centers and sides for thickness and weight, and cut them up into various widths for which the stock is most suitable; this is one of the most important processes in the making of leather belting.

After the leather has been cut to width it is transfered to the matching tables, where the pieces are matched in pairs and marked for the scarfing machine; this machine scarfs the laps to a length already indicated by the matcher.

From the scarfer the stock is taken to the feathering-machine operator, who feathers the edges of the laps prior to their going to the pressman to be cemented. The cement used is either our improved belt cement for regular belts to run under dry conditions, or our waterproof cement for waterproof belting. Perfect joints can be and are made with no other fastening than cement, and in most cases riveting or sewing the laps is superfluous; joints that are cemented only have the advantage of running smoother and with less vibration than belts fastened in any other way.

The belt next goes to the finishing department, where it is inspected and where the edges are finished either round or square as the case may be. During the finishing of the edges the belt passes through a stretching device which eliminates all of the stretch or surplus elasticity that may be necessary for good running.

The belt is next turned over to the final finishing table, where the edges are burnished and the roll made up ready for shipment and sent to the shipping department.

Every center-made belt six inches in width and over takes the central portion of one steer hide for every four feet of length single ply, and two steer hides for every four feet of length double ply. A large main-drive belt made by us was 243 feet long and 72 inches wide, three ply thick. It took the best or central portion of the hides of a herd of 549 steers to make this belt. The average area of a steer hide when it reaches our tannery is 40 square feet. The head, shoulders and bellies are trimmed off and tanned separately for shoe purposes, and only 14 square feet, or the central back portion of each hide, is used for first-class belting. This indicates one reason why good belting is expensive.

Belt Specifications

It is hard to suggest a belt specification which would be acceptable to every buyer and every seller, and there is a great divergence of opinion regarding such specifications. From my standpoint the following is reasonable in all respects:

1. The belting shall be short lap, cut from centers of the best oak-bark tanned belting butts, tanned with oak bark by the old slow and long-time process.

2. No piece of leather in the belt shall be more than 54 inches in length, including laps. The leather shall be cut lengthwise from the extreme end of the butt, eliminating shoulder, and offal of every description. No piece of leather in the belt shall be cut from a portion of the hide further away than 18 inches from the side of the backbone of the animal which shows through the center of the butt.

3. The weights shall be as follows: Single belts, 1 to 2 inches in width, 14 ounces to the square foot. Two and one-fourth to 5½ inches in width, 15 ounces to the square foot. Six inches and over in width, 16 ounces to the square foot. Double belts, 1 to 2 inches in width, 28 ounces to the square foot. Two and one-fourth to 5½ inches in width, 30 ounces to the square foot. Six inches and over in width, 32 ounces to the square foot.

The above weights are for the very best brands of heavy oak-bark tanned leather belting. Of course, belts lighter than these weights can be made and are lower in price. The quality of the leather is just as good but the substance of the belt is thinner. A second weight would be one ounce per square foot under the weights above enumerated, and for a very light-weight solid-stock belt the weights would be two ounces less per square foot than the weights above enumerated.

4. Laps. In single leather belts six inches wide or less, no laps shall exceed seven inches in length, or be less than 3½ inches in length. On all wider sizes of single belts no laps shall exceed nine inches in length or be less than five inches in length. In double leather belts, no lap shall exceed six inches in length, nor be less than 3½ inches in length.

5. Cement. All laps of leather belting shall hold securely in every part, and when pulled apart the surfaces then exposed shall show no resinous, vitreous, oily, or watery condition.

6. Tests. Belts must show an elongation of not more than 15 per cent. for single belts, and not more than 13 per cent. for double belts when subjected to a stress of 1500 pounds per square inch; the elongation to be measured under stress. The breaking strain should be about 3200 to 3500 pounds per square inch of unstressed cross-section, both single and double ply.

Belting Factors

Regarding belting factors there are many rules and regulations that are published and talked about. In Europe they use single belts for everything, whereas in America most of our belts above five or six inches in width are double ply. They carry the single-belt theory to an extreme and use single belts a meter wide. Their idea is that a single belt runs better and will transmit much more power than the same amount of leather put into a double belt; this, however, is not true because the transverse strain on a wide single belt weakens it, and a double belt over eight inches is a good investment for any service and is really necessary as a reserve power. In general they figure too close on the power-transmission proposition in Europe and the belt gets the worst of it. Some of these ideas are coming more and more into vogue here. My opinion is that the old rules that have been used for the past 40 or 50 years are the best.

Regarding the length of belts, it is generally safe to figure that the minimum distance between centers should be three and one-half times the diameter of the largest or driving pulley.

A good transmission rule, and one that leaves sufficient reserve power in the belt, is to divide the number of feet that the belt travels per minute by 800; the result is the number of horsepower that a 1-inch single belt will transmit; in other words, if a belt travels 2400 feet per minute, according to this rule a 1-inch single belt under this condition would transmit three horsepower, a 10-inch belt 30 horsepower, and so on.

A good rule for double belts is to divide the number of feet that the belt runs per minute by 500; the result is the number of horsepower that a 1-inch double belt will transmit; in other words, a double belt 1-inch wide running 2500 feet per minute will transmit 5 horsepower, and wider belts in direct proportion.

These are both old rules but they are safe.

It is impossible to give a hard and fast rule in regard to shortening a new belt before it is placed on its pulleys, and in regard to taking up belts that are in use. The factors for such shortening would vary with the different tannages of the belt leather. The old long-time process of tanning gives a long-fibered leather with more elasticity, more life and more staying power than the shorter-tanned leather. A shorter-fibered leather does not stretch as much as the longer fiber, and while it may have a greater tensile strength in the beginning it lacks the

durability of the old-style long-fibered oak-bark tannages.

Thus, while it is impossible to lay down an exact rule regarding how much shorter belts should be cut than the actual tape-line measurement around the pulleys, it is safe to say that the average leather belt in the market today should be cut two inches short for each 10 feet of tape-line measurement; thus a belt that is to be 30 feet long when in place on its pulleys should be cut 6 inches short and this 6 inches stretched out of the belt when it is put in place.

By following this method a belt properly selected for the work it is to do should not have to be taken up at frequent intervals.

In regard to a factor for shortening belts in use the same conditions confront us as regards the different tannages of leather as have been mentioned above, that is, the short-fibered leather stretches less and has less elasticity and a shorter life. Two per cent. of the length should be the maximum that a belt will stretch unless it is severely overstrained. Any belt that stretches over 2 per cent. of its length is overstrained, and is liable to break if stretched to a much greater degree.

Care of Belts in Service

Regarding the care of belts in service, belts which are subjected to extreme heat or dryness need a good belt dressing applied perhaps once every six months, in some cases oftener than this, but once every six months will harm no belt if it is properly done, and this treatment has a tendency to preserve the wearing quality of the belt.

For special service leather link belts are made for drives that have short centers, and are the only belts that we guarantee to run quarter turn; their usefulness, therefore, is limited.

Belt Efficiency

The most efficient belt can perhaps be defined as the one that will give the maximum number of horsepower-hours of service per dollar of belt investment. Sometimes engineers tell us that they wish to put in a temporary drive and that they do not expect the belt to last over three months or one year, or two years, as the case may be. On the other hand, we can point to belts that have been running day after day for some 28 or 30 years and they are still in good serviceable condition. It is evident that a larger belt investment is justified in the latter case than in the former, and such cases must be decided on their individual merits.

Perhaps a short rule for the purchaser to remember in order that he may select belts that will give him the maximum number of horsepower-hours of service per dollar of investment is to design the belts with plenty of reserve capacity.

If a belt is figured according to the ordinary rule given in a previous section of this article, there is a certain amount of reserve capacity, yet it is always safe to add to this another 10 or 15 per cent. for a long-life belt. The more reserve capacity the belt has, the longer will it last and the better will it withstand sudden and severe stresses.

However, all of this is a question of good judgment and common sense on the part of the engineer or mechanic who is putting in the drive. It should be remembered that the first cost of the belt is not the only consideration, neither can it be entirely ignored. For greatest economy, all the considerations must balance.

Leakage Past Various Types of Valve

By James Cannell

A resume of the available information upon valve leakage and deductions showing that this follows a provisional law for slide valves and piston valves.

In these days of strenuous attempts to obtain an engine of maximum efficiency, it is most unfortunate that there should be such a scarcity of reliable information regarding valve leakage. The valves in use at the present time may be classified into four groups: the slide valve, the piston valve, the Corliss valve and the drop valve. There are many varieties in each of the groups, but these variations do not affect them greatly as regards their ability to prevent steam leakage.

It appears that only the slide valve has been tested for steam leakage in a manner that can be accepted as reliable. This was done by Messrs. Callendar and Nicolson in a series of tests on a 10½x 12-inch engine at McGill University, the report of which is to be found in the *Proceedings* of the Institution of Civil Engineers, Volume CXXXI.

Tests were first made to find the difference between the leakage with the valve as it was and the leakage after the valve had been carefully scraped and refitted. As a result of these tests it would appear that the leakage is not merely a question of such minute differences of fit as could be corrected by scraping. Trials were then made at different pressures in order to find the rate of leakage.

From tests with two other slide valves in addition to this, the investigators were able to formulate a provisional law for leakage, they having found that the leakage was independent of the speed and that the results were remarkably consistent. The formula is:

$$K = \frac{CP}{L}$$

where

K = Rate of leakage in pounds per hour per pound difference of pressure;

C = Coefficient depending upon the nature of the oil film; for slide valves, this varies from 0.20 to 0.22.

P = Perimeter of port;

L = Mean overlap.

During the tests it was seen that the rate of leakage appeared to increase slightly as the oil film was gradually dissipated. It is probable that this film of oil makes the valve steam tight when it is still, but as soon as it begins to move, the oil film becomes broken up and leakage occurs.

The only tests of leakage in a piston valve of which the writer has knowledge, were made by Mr. Mitchell at the University of Pennsylvania and published in the October 11 issue of Power. It is unfortunate, however, that these are presented in such a manner that an analysis of the tests gives only an approximately correct result, but it gives the data necessary for arriving at a formula for expressing the rate of leakage.

In these tests the leakage is shown to increase at the rate of three pounds per horsepower per hour. As the description appears to indicate that the engine was governed through varying the expansion, this leakage evidently occurred at a practically constant pressure difference. The length of the valve face was $1\frac{1}{16}$ inches, the total length, therefore, being $2\frac{1}{8}$ inches, and the perimeter of the port was 17.3 inches. According to the foregoing experiments on leakage through a slide valve, the rate of leakage would be constant under the same conditions as just given for the piston valve, and it is not conceivable that it would be otherwise with a piston valve. Hence, taking the average leakage as given, 185 pounds at 100 pounds pressure, the law of slide-valve leakage can be applied to the piston valve and the value of the constant C can be found for piston valves.

$$C = \frac{LK}{100\,P}$$

$$C = \frac{2.125 \times 185}{100 \times 17.3}$$

$$C = 0.227$$

From this it is seen that this test shows the coefficient *C* to be practically the same for piston and slide valves.

The following tests illustrate the practical use to which this knowledge of valve leakage can be applied. They were made on a 330-kilowatt high-speed engine fitted with piston valves and the experiments were carried out in order to improve the economy of the engines of this type.

They were first made at various loads with a standard engine which had valves without rings, and which had run for some days to give its bearings, piston rings, etc., time to get to a proper working fit. The engine was governed by the throttle. The curves, here shown, representing the total steam per hour, follow Willan's law.

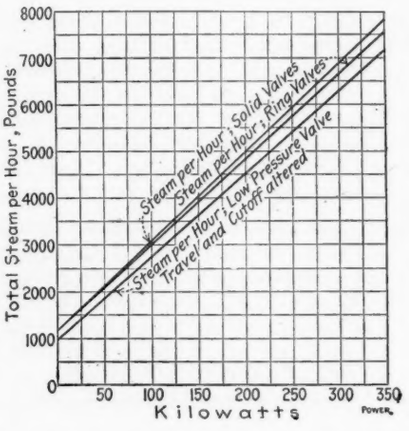
The curves show that the gain in economy with the ring valves is about 3 per cent. at full load, but at light loads there is practically no gain. This gain at full load was greater than was expected and the gain diminishing with the load is probably explained by the fact that the pressure is reduced with the load.

It was then decided to lengthen the travel of the low-pressure valve by fitting a new low-pressure eccentric; this permitted a greater length of valve face, and, as Messrs. Callendar and Nicolson found that the leakage of a slide valve was directly proportional to the length of the face, it was hoped that an appreciable saving would be effected in the economy of the engine. The travel of the valve was altered from 4½ to 6½ inches and at the same time it was arranged to cut off at 45 per cent. of the stroke instead of 60 per cent. This enabled a still greater length of valve face to be obtained. Altering the cutoff in the low-pressure cylinder does not affect the power of the engine but it slightly alters the distribution of the load between the cylinders. These alterations increased the length of the valve face from 4½ to 6 inches at the top end and from 4¼ to 5¾ inches at the bottom, giving a total difference of 34 per cent.

The results of tests at various loads with the longer travel low-pressure valve are shown by the bottom curve. Comparing these with the previous tests in which ring valves were used, it is seen that there is a gain by giving a longer travel to the low-pressure valve and having an earlier low-pressure cutoff of about 4.5 per cent. at full load and about 7 per cent. at half load. Also, the curves show that 350 pounds of steam per hour has been saved at full load but the saving gradually decreases as the load decreases.

It might be considered that altering the low-pressure cutoff improves the economy of the engine; however, it has been proved that this does not affect the economy in the slightest degree, both on piston-valve engines and on slide-valve engines.

As far as can be ascertained there are no published tests of the steam leakage of Corliss valves. It would seem probable that the leakage would follow a law somewhat similar to that of slide-valve leakage. However, it is shown by Messrs. Callendar and Nicolson that this should not be so in actual practice as with this type of valve both the live and exhaust steam do not pass through the same valve. They stated that the leakage probably occurred mainly in the form of water which was condensed on the valve faces, and then reëvaporated. As the result of their tests, they stated that this leakage might be greatly reduced by jacketing or otherwise heating the valve seat and thus minimizing the condensation; furthermore, that an engine with



LEAKAGE AT VARIOUS LOADS

separate steam and exhaust valves would possess advantages as regards steam leakage over a slide-valve engine, owing to the smaller condensation on the steam-valve face.

In the discussion on a paper read before the Institution of Mechanical Engineers in July, 1904, Mr. Longridge stated that superheating played an important part in reducing valve leakage. With fluids of small viscosity, such as steam and water at high pressure, the velocity of flow through a small orifice such as might be supposed to exist between a valve and its seat would depend almost entirely upon the difference of the pressure and would be practically equal under a given pressure whether the leaking fluid were steam or water. As the density of water is so much greater than that of steam, it is easily seen that the weight of water leakage would be very much greater than that of steam, and the effect of condensation is evident.

With drop valves the seats are either flat or conical. Experience has shown that flat seats are preferable provided the dashpot is of an efficient type; or if a positive gear is used, it might be considered that the leakage through these valves would be practically nil, for when steam is not being admitted the valves are on their seats and there is no clearance between the valve and its seat. This, however, is not true in practice, for even with the valves made to fit as perfectly as possible there is a slight leakage of steam, and if they be of large diameter this leakage becomes sufficient to run the engine if a high vacuum is maintained in the exhaust pipe and there is no load.

Tests showing the leakage of these valves have not been published, but in Volume CLXXIII of the *Proceedings* of the Institution of Civil Engineers, Mr. Preece shows that the leakage is less than with valves which have rubbing surfaces where a certain amount of clearance is necessary.

In actual practice with piston- or slide-valve engines the gain due to superheat is much greater than the gain with the same amount of superheat in drop-valve engines. This larger gain is maintained up to a certain degree of superheat, after which the gain due to increased temperature is practically the same for both types of engines, and this is correct whether the engines be expansion or throttle governed. This can be explained only by the fact that the condensation on the valve face of the slide or piston valve is decreased by the increasing temperature until the point has been reached at which the leakage of these types of valves becomes equal to that of the drop valve, the cylinder condensation and all other things affected by the superheat being the same with each type.

Warnings

The Manchester Steam Users' Association issues the following:

Don't overload the safety valves or tamper with them.

Don't let the water level sink out of sight.

Don't allow the cocks and valves to set fast.

Don't open the steam stop valves hurriedly.

Don't empty the boiler while steam is up.

Don't open manholes before easing safety valves.

Don't raise steam hurriedly.

Don't use unknown scale solvent or compositions.

Don't slake ashes against boiler fronts.

Old Hal Mossback, th' ingineer et th' ladies' rat factery, went t' sneeze tother day and his false teeth drapped out an' rolled inter th' flywheel. Hal wanted t' shet down an' get 'em out but th' boss told 'im the th' wimmin hed th' rat bizness rushed so dumd hard thet they didn't hev time t' stop. Hal sed he gessed thet et wuz up t' 'im ter live on soup th' rest uv th' week.

Cooling System for Condensing Water

By R. O. Warren

A homemade tower costing but $425 for material and labor lowers the temperature 50 degrees of all the circulating water used for 1500 horsepower of condensing engines.

A homemade cooling tower, costing but $425 for labor and material, is installed at the power plant of the Fitchburg & Leominster Street Railway Company, Fitchburg, Mass.

There is a made pond, having a natural bottom and concrete side walls, that contains the water used for condensing purposes. City water is used exclusively for boiler feed, which, when condensed, is discharged into this pond, the supply being more than sufficient to make up for the loss by evaporation. The pond is 70x70 feet, with a depth of 7 feet. Pond water is not used for boiler feeding, because it is contaminated to a considerable extent with dirt and oil.

The design of the cooling tower is shown in the accompanying illustrations. It is a structure 150 feet long and 10 feet wide, equipped with three cooling platforms, as shown in Fig. 1.

The platforms, all of which have a drop of 1 foot in 50, are made of 2-inch spruce planking and are supported by 6x6-inch timbers, each 8 feet long. The top cooling floor has baffle strips secured to the upper surface in the form of a V, which ruffles the water and causes some of it to fall over the edges of the platform, as shown in Fig. 2. There are four rows of side deflecting pieces, also shown in Fig. 2, the three top deflectors slanting toward the outside edge and downward; the lower one slants toward the bottom floor. This arrangement causes the water to drop from one deflector to the next one below, the bottom deflector catching the water and diverting it to the lower cooling platform.

The condensing water is discharged from a jet condenser through a 14-inch pipe which is capable of taking care of two of the largest engines in the plant. The second discharge pipe is 10 inches in diameter and is connected to a second jet condenser. Both of these pipes are fitted with a Y connection, so that by opening a valve in the bottom pipe, the condenser water can be discharged direct to the pond through the lower pipes, shown in Fig. 3, without passing over the platforms of the cooling tower. This is desirable when the water is at a high level in the pond due to heavy rains, for it is then cool enough for condensing purposes. The discharge from the lower platform is onto a float, as shown in Fig. 2. This causes the water to flow into the pond in a thin film from the four sides of the float.

The temperature of the circulating water, after passing over the cooling platforms is lowered 50 degrees Fahrenheit. The tower will easily handle the

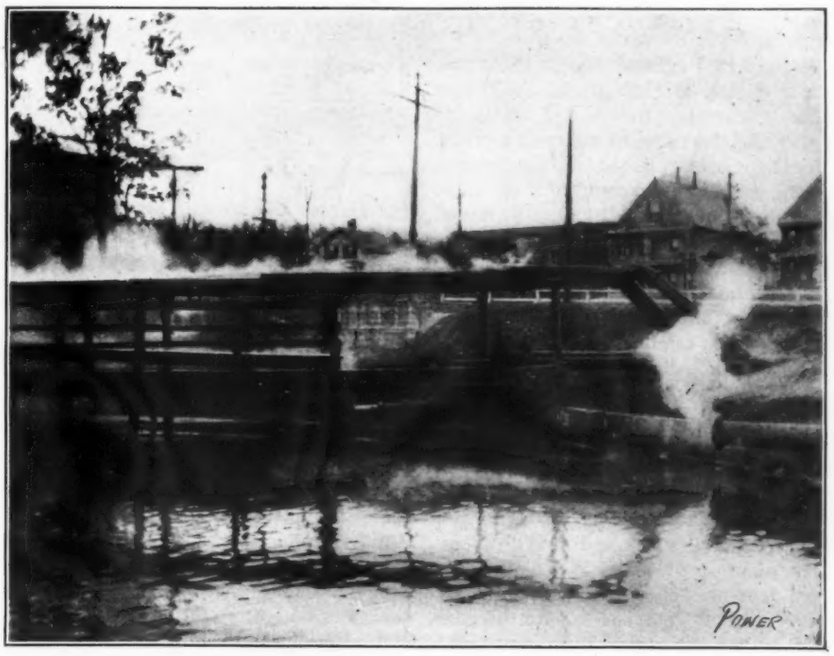


FIG. 3. ARRANGEMENT OF DISCHARGE PIPES

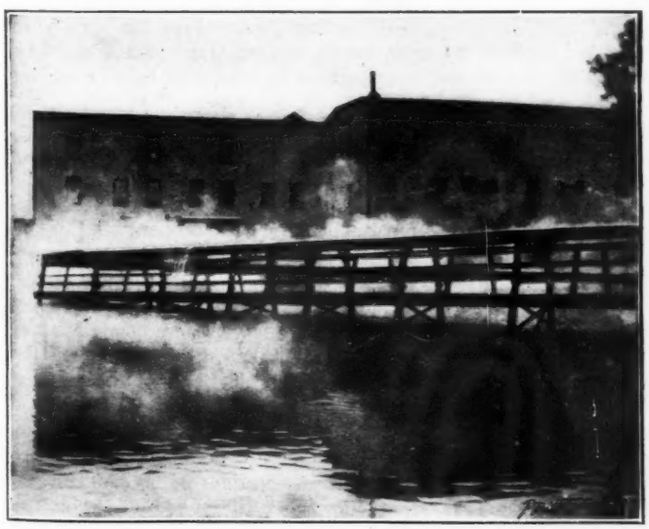


FIG. 1. SHOWING THREE COOLING PLATFORMS

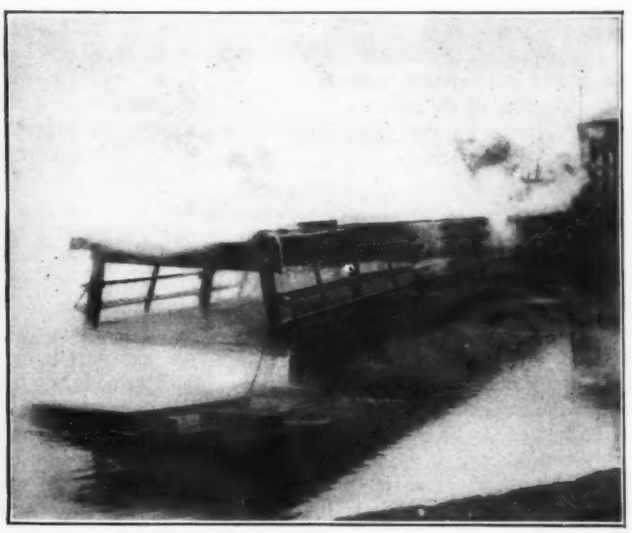


FIG. 2. SHOWING DEFLECTING BOARDS

condensing water for 1500 horsepower of engines and 2000 horsepower if necessary, although there would be less drop in temperature with the greater quantity.

The pond is connected to the suction well by a 24-inch pipe. In case it is necessary to clean the well, a gate is lowered over the end of the 24-inch pipe leading to the pond. The slides for the gates are made of railroad rails and the gate is raised by means of a handle passed through an extension rod.

Special Setting for Water Tube Boilers

By Edward J. Kunze

An outline of the fundamental principles of combustion and heat transmission, application of which is made in a special form of setting intended to eliminate smoke when using soft coal.

*From a paper delivered at the annual meeting of the Michigan Engineering Society, January 11, 1911.

Viewed from the standpoint of smoke formation, one of the worst conditions where soft coal is used, is that of having the grate directly under the tubes in the first pass. In many plants, thus equipped, there is not enough space in front of the boilers to permit adding an extension furnace, and it is to meet this condition, particularly, that the setting here illustrated was designed. Before examining in detail the constructive features of this setting it might be well to consider the fundamental principles which underlie its use.

Among the agents that prevent the proper mixing of air and gas are the so called "neutrals" consisting mainly of carbon dioxide, nitrogen and water vapor. If enough neutral is added, combustion may be entirely prevented. For instance, if one part of carbon dioxide is mixed with seven parts of a combustible mixture of gas and air, ignition and combustion will not take place. Likewise, if one part of nitrogen is mixed with six parts of the combustible mixture, the power of combustion is nullified. Therefore, it is important that the neutrals be removed from the combustible matter as soon as they are formed. If the water vapor, formed by combustion, is allowed to mix with the heated gases, it may also become dissociated, taking up heat from the surrounding gases and cooling them.

The quantity of steam in a boiler produced does not depend upon the intensity of the fire, but upon the amount of heat absorbed by the water from the burnt gases which are the conveyer of the heat. According to Perry's theory, the rate of impartation to a boiler tube is for ordinary gases proportional to:

1. Temperature difference of the gases and the metallic surface.
2. Density of the gases.
3. Velocity of the gases parallel to the metallic surfaces.
4. Specific heat of the gases at constant pressure.

To these I should add:

5. Character of the metal surface.
6. Heat-conducting property of the metal.

Usually the first factor alone is considered. The second assumes that an increase in density causes the contact between the molecules of gas and the part to be heated, to be more intense. From the kinetic theory of gases the individual molecules of gas give up their heat by vibrating against the metal; the greater the number of molecular impacts per second against a unit area of the metal, the greater the amount of heat imparted to the metal. But the number of impacts is directly proportional to the density, which, in turn, at a constant pressure, is inversely proportional to the temperature. On this account there is a direct neutralization of gain when striving for high temperature; for, as the temperature is raised, the number of molecules in action against any portion of the heating surface is reduced.

Regarding the third factor, consider the molecules of the metal in a state of rapid vibration with spaces between them much larger than the molecules. Entangled among the outer molecules of the metal there would be comparatively stationary molecules of gas held close together in a dense film next to the metal. Farther out, normal gas is reached, where the molecules are widely scattered. These gaseous molecules would be in a state of rapid vibration, but those close to the metal would be more or less bound by the attraction of the metal, and serve as a poor conductor of heat. Hence, the hope of transmitting more heat lies in the dislodging of the slowly vibrating molecules and replacing them with rapidly vibrating or hot ones. The dislodging molecules fly back and forth perpendicularly to the surface, and this scrubbing effect on the layer adhering to the metal is proportional to the velocity of the gas parallel to the heating surface. This velocity, therefore, has an important influence upon the heat transmission.

The products of combustion at a high temperature take the shortest course and will not spread over the entire heating surface unless external means such as baffling are resorted to. In order to prevent the thinning out of the heat current or short-circuiting the flow, A. Bement advises increasing the number of passes. He gives, as a result of changing from the single to the double pass, an increase of 10 per cent. in efficiency and about 4 per cent. more horsepower than the regular design of boiler. The result of triple passing as compared with the single pass gave an increase in efficiency of about 20 per cent. and an increase in capacity of approximately 4 per cent. In other words, the increased capacity of this triple pass is the same as with the double pass, although the gain in efficiency is twice as great. With the double pass the draft at the fire was unaffected. With the triple pass, however, the resistance offered by the passages reduced the draft at the fire, so that less coal was burned than with the same boiler having a single pass; but this is not a serious objection, because more horsepower was produced. Since baffling of this character brings into use twice as much or more boiler surface than was formerly utilized, it justifies the realization of a much larger capacity and the use of higher draft.

In considering factor four, it is evident that since a given volume of any gas at any temperature and pressure contains the same number of molecules as the same volume of any other gas under the same conditions, and since various gases upon cooling give up various amounts of heat per degree of temperature drop, a given number of molecular impacts of different gases will give up more or less energy according as the specific heats of the gases are respectively higher or lower.

Regarding factor five, the nature of the metal surface, this affects the heat transference by its ability to more or less entangle the molecules of the gas.

The reversed setting here shown has been criticized because it requires a greater hight, of about 4½ feet, in both setting and boiler house, with a correspondingly larger investment and maintenance cost; also that the mud drum is over the ignition arch. It is claimed further that this arrangement is not as effective in producing complete combustion as one which pitches downward toward the back. The writer believes, however, that these objections are not well taken.

The advantages of a larger combustion chamber more than counterbalance the expense attendant upon a higher setting, and while it is admitted that the extra hight increases the cost of the building, it is more essential to decrease

floor space which is more valuable, especially in plants already constructed. Floor space costs more than hight in large cities; also it is more necessary to keep the floor space in the boiler room reduced to a minimum than is the case with the engine room, so that corresponding units, especially in steam-turbine plants, may be as close as possible to each other. Regarding the mud drum, this is protected by hollow firebrick, and it would not be heated to as high a temperature as is the case where unprotected in the rear of the boiler, as is true of many settings now in operation.

The last objection may be answered by saying that in the design here shown the gases are diverted downward and pass through a more or less restricted area before rising to the tubes.

Another objection that has been raised to the reversed setting is that the radiation and unaccounted for losses would be increased. The fact is that in the majority of cases these losses amount to about 1 per cent. of the total heat available and most of this loss occurs through and around the doors, and is due to the necessity of opening the doors for feeding, slicing, poking, etc. In the case of well pointed brickwork, it is often found necessary to heat the boiler room by some other means, not enough heat being radiated from the boilers.

The advantages of the setting, as submitted here, may be summarized as follows:

1. Increased combustion-chamber volume without increased floor space.

2. Decreased velocity of the gases as they enter the combustion chamber, since there is a gradual increase in cross-sectional area. This permits better mixture between the combustible gases and the air, tending to avoid the formation of air shoots or impinging streams of cooler air with the accompanying tendency to effect an unequal heating of the tubes and cause unequal expansion of parts. The better mixture permits a reduction in the percentage of excess air required, hence there will be less cooling of the gases and better economy. Ordinarily the time required for the gases to pass from the grate to the heating surface of the boiler averages considerably less than a second, which is a very short time for the processes of combustion to take place. If the passages are of large enough cross-section, a better opportunity is given for the neutral gases to separate from the burning gases; the latter, being hotter and lighter, will take the upper paths while the carbon-dioxide, water vapor and similar gases take the lower paths and avoid the detrimental action of preventing proper combustion. If the carbon dioxide generated on a thin fire is permitted to rise promptly from the fuel bed, as is the case when the space above the grate is large, there is less tendency for conversion into carbon monoxide. It is only when the carbon dioxide is passed through a thick bed of fuel or in close contact with an incandescent bed of fuel that this conversion takes place.

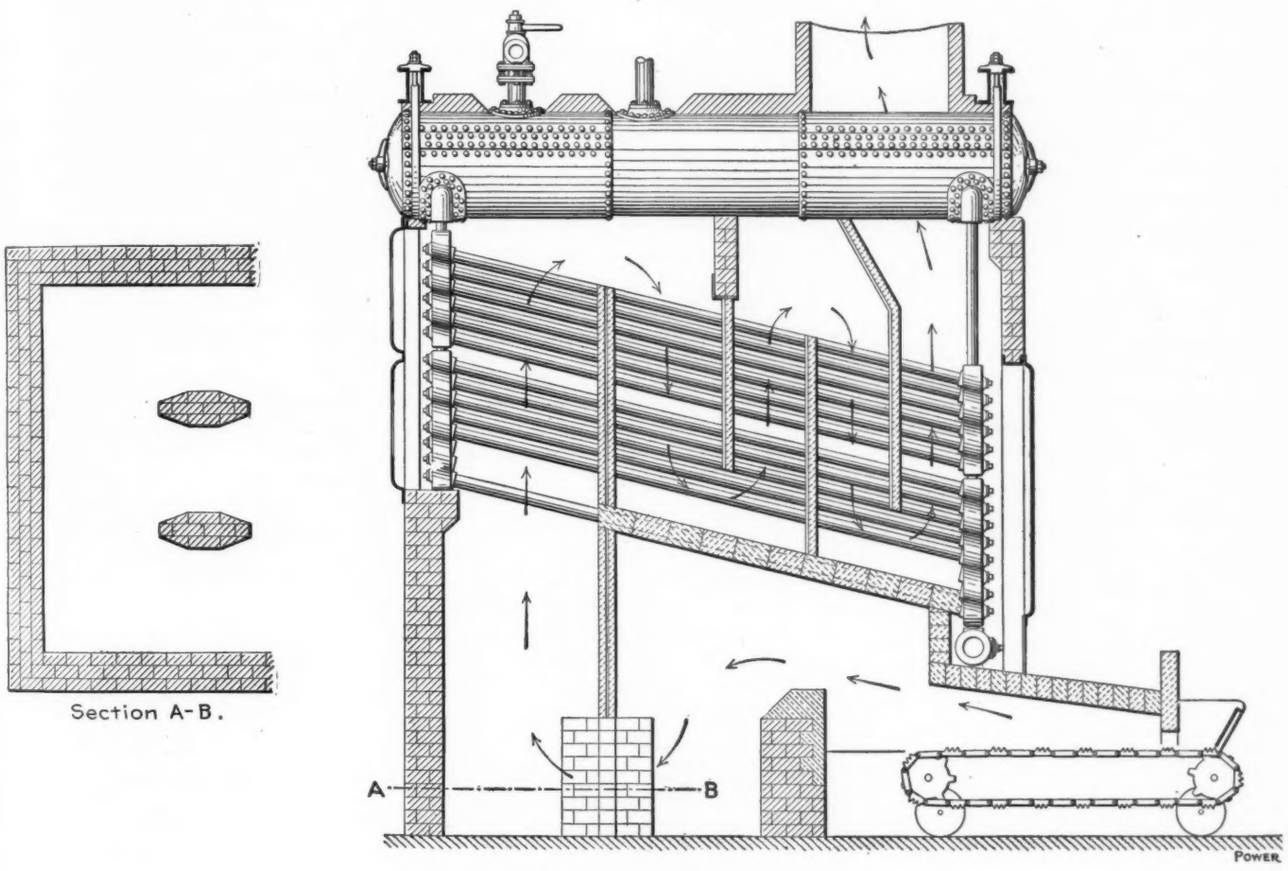
3. With the baffle in the rear, the gases are brought close together because of the restricted area, just before rising to the tubes; therefore, there is a greater tendency toward complete combustion, and equal heating exists.

4. The large combustion chamber affords a large capacity for heat storage.

5. The larger cross-sectional area of the combustion chamber permits the introduction of firebrick baffles, without reducing the area of draft.

6. There will be a tendency for a body of air or cooler gas to collect under the roof. This body would not move as fast as that directly in the line of travel. As this line of travel is lowered by the baffle in the rear, there will be less injury to the furnace roof due to erosion than in the case of the downward sloped roof.

7. The boiler tubes can be readily removed or cleaned from the front of the boiler, thus avoiding the requirement for much room at the rear of the boiler for this purpose.



SECTION THROUGH BOILER SETTING

Indicator Diagrams and Calculations

By Frank S. Bunker

The steam-chest and the friction diagrams and what they show. The valve-rod diagram and how it is obtained. Method of plotting the combined diagram and the diagram of useful work. How to estimate the quality of the steam and the cylinder clearance from the diagram.

The taking of indicator diagrams from the cylinders of an engine and the subsequent examination, together with the time-worn formula,

$$HP. = PLA\ (2N) \div 33{,}000,$$

using the mean effective pressure estimated from the diagram to ascertain the indicated horsepower, form a part of every engineer's stock in trade.

The indicator diagram is, in reality, a graphic portrayal of the performance of the working medium (steam, gas, etc.), in whatever type of machine it may be necessary to inspect.

With favorable conditions and an equipment in proper shape, diagrams may be obtained which can be accepted as an infallible guide. Every precaution should be taken so that the sample of the working medium tested by the indicator will have the same physical and chemical

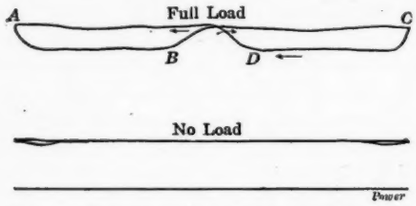


FIG. 1. STEAM-CHEST DIAGRAM AT FULL AND NO LOAD

qualities as those of the mass from which it is drawn. Care should be exercised so that the temperature, the degree of saturation or dryness fraction and the degree of superheat, if there be any, be unaltered. In other words, make the conditions in the indicator conform as closely as possible with those in the part under examination.

VALVE-CHEST DIAGRAMS

Diagrams taken from the steam chest

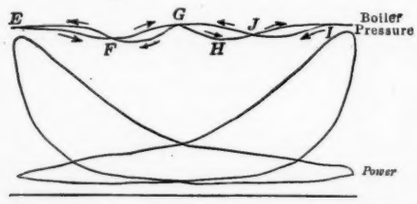


FIG. 2. COMBINED STEAM-CHEST AND CYLINDER DIAGRAMS

of an engine are always advisable as they show the fluctuation of pressure that takes place there and are thus a very good indication of the adequacy or the inadequacy of the carrying capacity of the steam-supply pipe which for many reasons may not supply the engine with the necessary number of B.t.u. An insufficient supply may be due to too small a supply pipe, a very crooked pipe offering an excess of friction or to an exceptionally long pipe improperly insulated, thereby causing excessive condensation.

Fig. 1 shows diagrams taken from the steam chest of a high-speed engine under full load and under no load. The speed was 325 revolutions per minute and the cutoff, ⅔ of the stroke. As the valve opened at points *A* and *C*, the pressure dropped, thus showing the draining influence of the engine on the steam supply. When cutoff occurred at *B* and *D* the pressure rose to boiler pressure.

Fig. 2 shows combined steam-chest and cylinder diagrams from a twin-cylinder high-pressure launch engine with atmospheric exhaust. One steam chest supplied both cylinders with steam through two D-valves. The valve opened to steam at *E* and caused a drop in pressure until cutoff at *F*, after which the pressure rose to *G*, at which point the companion cylinder began to take steam and cause the drop in pressure to *H*. After cutoff the pressure again rose to boiler pressure until the end of stroke, when the opposite end of the first cylinder again took steam, causing a drop along the line *I J*, and thus the cycle was continued on back to the original point *E*.

FRICTION DIAGRAMS

Another diagram of vast importance is the friction diagram. With its aid it is possible to estimate the amount of power necessary to overcome the friction of the engine. Such diagrams are taken in the usual manner with the engine running at full speed but with absolutely no outside load.

Fig. 3 shows a set of friction diagrams taken on a cross-compound automatic engine of 1200 horsepower capacity. The boiler pressure was only 37.5 pounds. The high-pressure diagram was taken with a 15-pound spring and the low-pressure with a 10-pound spring. The high-pressure diagram indicated 81.7 horsepower and the low-pressure indicated — 5.2 horsepower. This nets a total of,

$$81.7 - 5.2 = 76.5$$

indicated horsepower. It therefore required 76.5 horsepower to overcome the internal friction of this 1200-horsepower engine.

Friction diagrams are valuable for they give information which will oftentimes indicate trouble due to increased friction and consequently increased waste of power.

THE VALVE-ROD DIAGRAM

Although the valve-rod diagram is unique, very valuable information may be obtained from it. The indicator is placed on the cylinder of an engine having an inertia governor and consequently having a variable valve travel. The paper drum receives its motion from the travel of tho valve stem. The length of the diagram should be as near as possible some even fraction of the valve travel as ¾, ½ or ⅓, as this will greatly facilitate later computations. Having determined this fraction it will be necessary to open the valve chest and obtain the following data for use with the diagrams: width of steam port, steam lap and exhaust lap when the valve is in mid-position.

With these data as a guide, a valve model is constructed, as shown below the diagram in Fig. 4. The line *C L* being the mid-position, lay off from it equidistant on each side the distances *K* and *L* equal to the exhaust lap and the distance $K + M$ and $L + N$ equal to the steam lap. The distances *P* and *Q* are equal to the width of the steam ports and the total distance overall is the total valve travel. The diagram shown in Fig. 4 is a facsimile of a diagram obtained in the manner described, by giving the paper drum its motion from the valve travel.

After dividing the total length of the

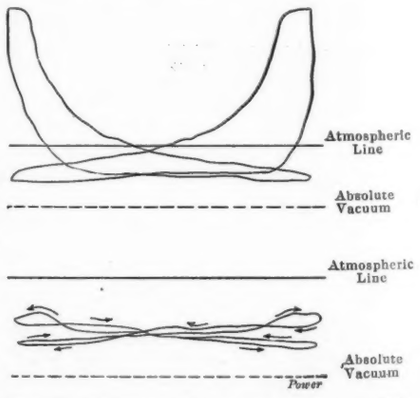


FIG. 3. FRICTION DIAGRAMS FROM A 1200-HORSEPOWER COMPOUND ENGINE

diagram into two equal parts and marking the center as the mid-position, then by placing the valve model *mid-position* in line with this position and extending the various lines in it upward until they cut the diagram the perfect cycle of events is shown much more clearly than with diagrams of the ordinary kind. At *a*, exhaust has just closed and compression begins and when the valve has traveled the distance equivalent to *K* the valve is in mid-position. Compression

continues until the distance $L + N$ has been traveled, when the valve opens to lead and the pencil rises along the steam-inlet line and continues on along the steam valve closes, cutoff is completed and expansion begins. During the expansion of the steam in the cylinder the valve must travel through the distance

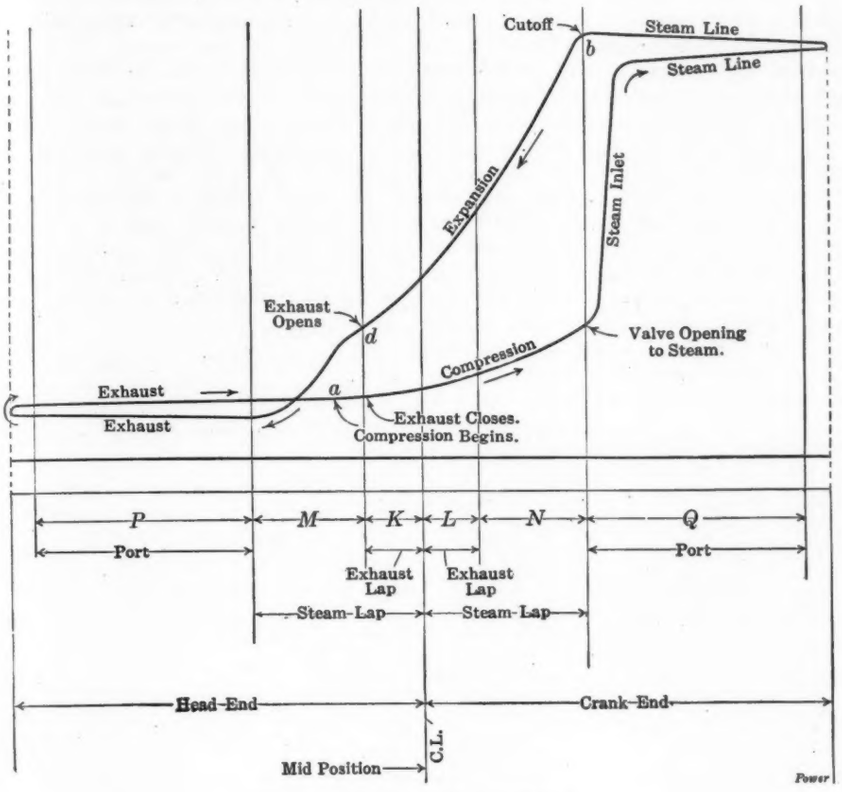


FIG. 4. VALVE-ROD DIAGRAM

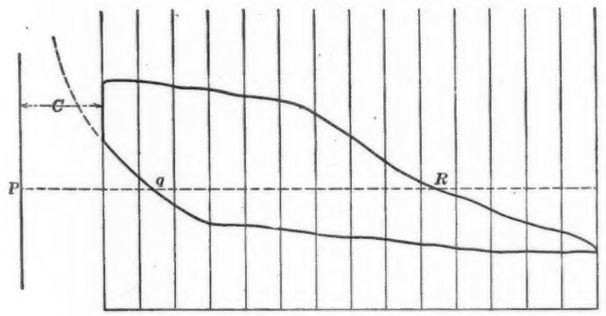


Diagram from High-pressure Cylinder.

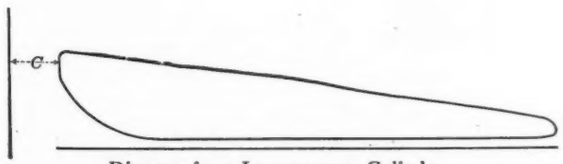


Diagram from Low-pressure Cylinder.

FIG. 5. HIGH- AND LOW-PRESSURE CYLINDER DIAGRAMS

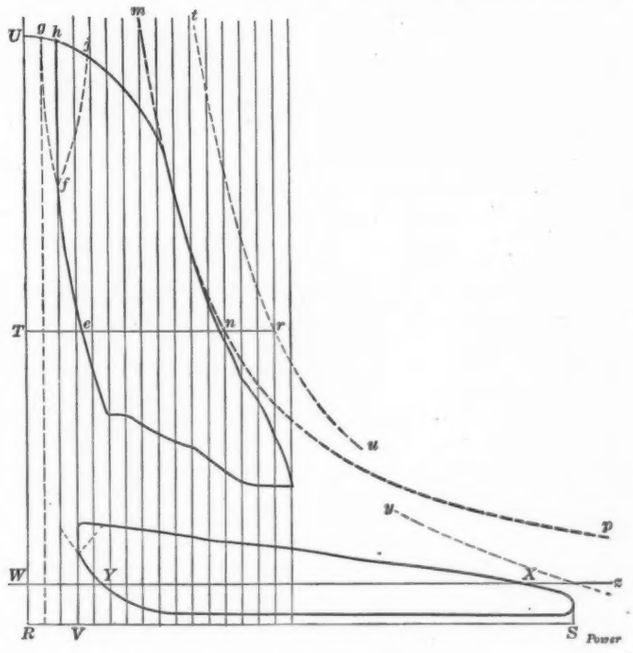


FIG. 6. THE COMBINED DIAGRAM

steam line to the end of the valve travel, getting slightly higher as the valve opening increases and slanting downward as the valve opening diminishes until the point b is reached. At this point the $N + L$ or the steam lap and through the distance K or the exhaust lap. At the point d the valve opens to exhaust and the pressure drops until forced to rise slightly by the forcing effect of the piston in purging the cylinder. The pressure continues thus until the exhaust closes at a. On no other type of diagram can the points of absolute cutoff and release be ascertained as accurately as on this type; and as the load changes and the valve travel increases or diminishes, the same events may be distinguished even though the travel becomes so short as not to allow the valve to uncover the steam ports.

A leaky piston may be indicated by this diagram as well as by any other, and in the case of leaky valves it will show the exact point in the valve travel at which the leak occurs.

The diagram may be taken from any engine having a piston or slide valve. It is exceptionally valuable with engines having inertia governors as it gives accurate information in regard to the action of the governor during operation when it is not possible to get data in any other way.

THE COMBINED DIAGRAM

It is often necessary to reconstruct the diagrams obtained from an engine the better to portray the performance of the machine. This is especially true of compound-, triple- and other multiple-expansion engines for which the diagrams are so reconstructed as to appear as if the steam had acted all the time upon the low-pressure piston only. In reconstructing diagrams of this type they are all plotted upon the same *volume* base, but with the respective pressures represented by ordinates whose lengths are directly proportional as the scales of springs used.

Fig. 5 shows indicator diagrams from the high- and low-pressure cylinders of a very poorly designed engine. The

spring used for the high-pressure diagram was calibrated for 100 pounds; that for the low-pressure, 40 pounds. The cylinders were 20 and 30 inches in diameter, respectively.

In Fig. 6, $R S$ is the atmospheric line and the vertical line $R T U$ is the line of zero volume. The low-pressure diagram is here plotted with the clearance volume shown as $R V$. The horizontal line $W X$ is the pressure line of the low-pressure diagram.

Returning now to the high-pressure diagram in Fig. 5, it is necessary to divide the diagram into a number of ordinates for future plotting. As the high-pressure spring was 100, and the low-pressure spring 40, in plotting the high-pressure diagram in the proper proportion it will be necessary to multiply each ordinate in Fig. 5 by $\frac{100}{40}$ or 2.50 before transferring to Fig. 6. Furthermore, the

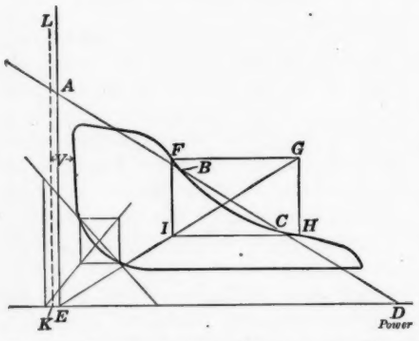


FIG. 7. ILLUSTRATING METHOD OF ESTIMATING CLEARANCE

diagrams must be on the same volume base; and as the cylinders were 20 and 30 inches in diameter, the volumes swept through by the pistons vary as

$$20^2 : 30^2 \text{ or } 4 : 9 = 2.25.$$

Therefore, the horizontal length of the high-pressure diagram must be reduced by dividing its total length by 2.25. The reconstructed high-pressure cylinder appears in Fig. 6 in the upper half. In this diagram the work done in the high-pressure cylinder is represented on the same scale as is that done in the low-pressure cylinder.

The length $V S$ represents the volume swept through by the piston and $R V$ the clearance volume. At the pressure $R W$ the actual volume of steam expanding in the cylinder is represented by $W X$. Of this total volume the amount $W Y$ was trapped by the valve at the commencing of compression. Therefore, the volume represented by $Y X$ is the steam which entered as new steam while the steam port was open and which will pass out during exhaust.

In the high-pressure part of the reconstructed diagram it will be seen that if the compression of the imprisoned steam had continued up to the initial pressure, the compression curve would be as $e f g$ and the clearance volume would be quite full of steam at that pressure at the beginning of the stroke. All steam which then entered the cylinder would perform useful work while the compressed steam would act merely as a buffer and would exert as much work on the piston as was expended on it by the piston during compression. It therefore would neither contribute nor detract from the net useful work performed. When the cushion of steam is not compressed to boiler pressure, the incoming steam performs that function. The clearance volume represented by $U h$ is filled with steam at the beginning of the stroke and the volume of the cushion steam at the same pressure is represented by $g h$. The difference or $U g$ is, therefore, the volume of steam necessary to complete compression and the area $f g h$ represents the amount of work lost thereby. This is replotted as $h j f$ and this indicates the reduction of the area of useful work.

By referring now to a diagram of a rectangular hyperbola and placing the line of zero volume on the vertical axis $R U$ and the line of zero pressure on the atmospheric line $R S$, the curve which most nearly corresponds to the expansion curve of the two diagrams may be plotted as $m n p$.

The area between the two diagrams represents the loss due to the poor construction of the engine and the faulty proportions of the design. The area between the hyperbolic curve and the diagram areas represents the losses due partially to this cause and partially to throttling, wiredrawing, radiation and condensation, and if an adiabatic curve is drawn in place of the hyperbola, the loss will show as due to condensation in the cylinders over and above what would have occurred with adiabatic expansion in cylinders which were nonconductive.

STEAM QUALITY

The quality of the steam as it passes through an engine may be determined from the combined diagram. During the test determine the steam consumption and from this calculate the weight of steam used per stroke. Draw a horizontal line as $T e n r$ so as to cut the expansion and compression curves. The line $T e$ represents the cushion steam and $e n$ the actual volume of steam passing through the engine per stroke. The line $t r u$ is a saturation curve. Then $n r$ must represent the volume of steam which has condensed and exists as moisture at that pressure.

If $n r$ represents the moisture and $T n$ the dry saturated steam in the cylinder and clearance space, then $\frac{Tn}{Tr}$ will represent the fraction of the whole which is dry saturated steam.

This is called the dryness fraction. To determine the location of the saturation curve on the diagram it is necessary to find the point r. The distance $e r$ is laid off to represent the volume of steam used per stroke of the engine as spoken of previously.

As the same total weight of the steam and water mixture will exist throughout the stroke, it is only necessary (by reference to steam-saturation tables) to obtain the volume of that weight of dry-saturated steam at various pressures and to plot them at the right of the compression curve which, if too short, may be continued by reference to the rectangular hyperbola, as in the dotted line $f g$.

The same process is followed for the low-pressure cylinder and is necessary on account of the difference in the clearance space of each cylinder. The line $y z$ is the saturation curve of the low-pressure diagram.

ESTIMATING THE CLEARANCE

The clearance space of an engine is generally calculated from the working

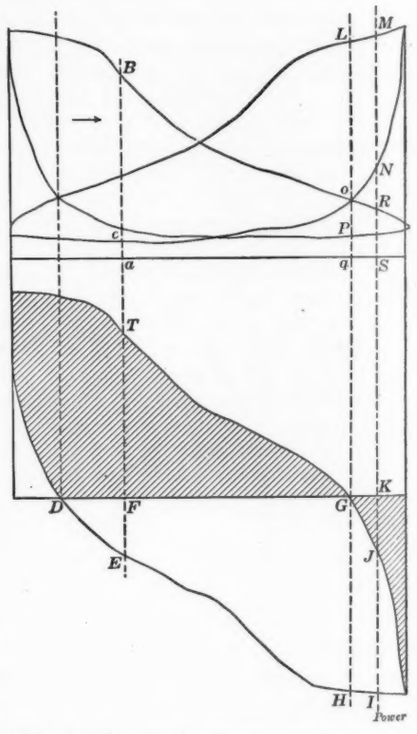


FIG. 8. RESULTANT-PRESSURE DIAGRAM

drawings of the engine. It may also be found by filling the cylinder and clearance space with water and in this way calculating the required volume. Fig. 7 serves to show the way to approximate the clearance volume from an engine diagram. Draw any line $A B C D$ cutting the expansion line and lay off from B a distance $B A$ which is equal to $C D$. Through A erect the perpendicular $A E$ to the atmospheric line $E D$. Another method is to construct a rectangle as $F G H I F$ parallel to the atmospheric line and with opposite corners on the expansion line $F H$. Then, the opposite diagonal is drawn and extended until it intersects the atmospheric line as at E. The same method may be followed with the compression

curve and a general average taken of all the results as the dotted line $K L$ which is then drawn. Its distance from the diagram area as V represents the approximate clearance volume of the particular cylinder under consideration.

Useful-work Diagram

It is often useful to reconstruct a set of diagrams to obtain the resultant of the positive and negative pressures acting on the piston. This is a graphic portrayal of the useful work done by the working medium. Such a diagram is shown in Fig. 8. At any point a in the stroke of an engine the pressure exerted for useful work is represented on the diagram by $a B$, and the pressure on the opposite side of the piston by $a c$.

The resultant effective pressure is therefore the differences between these two or $c B$. In plotting the resultant-pressure diagram, effective forward pressures are all plotted above a central line and effective pressures in the opposite direction are plotted below the line. Let $D F G K$ represent this central line. At F plot $F T = c B$. When the piston reaches q the forward pressure is $q o$, but the back pressure due to compression on the opposite side of the piston is also $q o$, so the effective forward pressure is zero and the resultant pressure line therefore crosses the base line at G.

With the piston at S and still moving in the same direction as the arrow the forward pressure is $S R$ and the back pressure $S N$. The resultant is the difference or $R N$ and is in the backward direction and therefore is plotted downward at $K J$. As the motion continues the same process is carried out. The cross-hatched section above the line represents the useful work done on the piston in the forward position by the steam and the shaded area below the line represents the negative work due to the purging action of the piston during exhaust and the compression. The same process may be followed for the return stroke and effective pressure plotted below the line and negative work above. The area between the two curves thus obtained would represent the net useful work performed during the two strokes or one revolution.

The resultant-pressure diagram is very necessary in the designing room and also very useful to the operative engineer.

The net area of useful work designated by the resultant-pressure diagram should always equal the area of the indicated horsepower diagram.

In calculating the mechanical efficiency of an engine, it is necessary to subtract the frictional horsepower from the indicated horsepower and divide this result by the indicated horsepower, thus,

Indicated horsepower, 1200; frictional horsepower in high-pressure cylinder, 81.7; frictional horsepower in low-pressure cylinder, — 5.2.

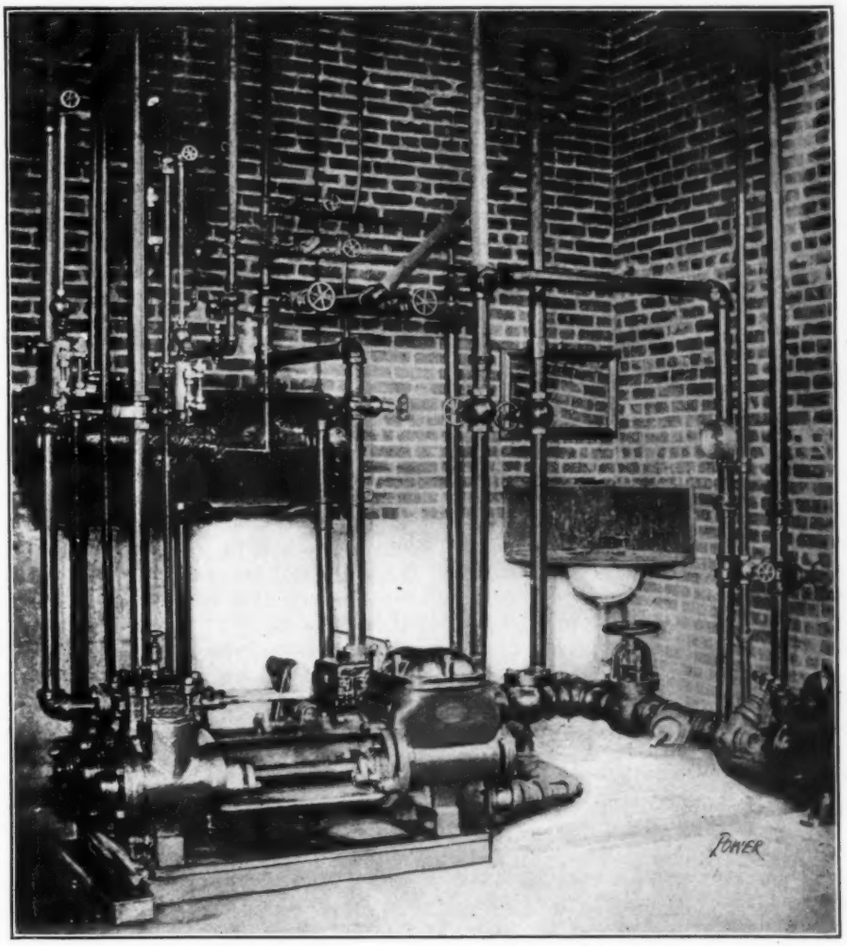
$$\frac{1200-(81.7-5.2)}{1200}=\frac{1200-76.5}{1200}=93\tfrac{6}{10}$$

per cent..

The friction is greater at heavy loads than at light loads although not necessarily much greater. The probable mechanical efficiency of this particular engine at full economical load would be about 92 per cent., which is excellent.

Attractive Piping Job

The accompanying illustration shows a neat layout of pumps, receiving tank and piping. The duplex pump is used for boiler feeding, the single pump for producing the vacuum on the heating system, and the small pump for house purposes.



Piping Job That Allows Freedom about the Pumps

The receiving tank is piped to all of the returns leading from the factory. It is also connected to the city main and the make-up water is controlled by an automatic regulating float valve.

The construction of the stand supporting the tank is worthy of notice. It consists of two vertical pipes which are screwed into floor plates. A tee is screwed onto the top of each upright pipe and a horizontal pipe is screwed into the tee, the outer end fitting in a hole in the wall. The top end of each tee is fitted with an extension piece which is capped. This framework holds the tank clear of the floor and raises the float governor gear out of danger of being damaged.

The pumps are so connected that either one can draw from the receiving tank or from the city-water main. An injector, not shown, can also be used as a boiler feeder.

The trap above the return tank handles all the returns from the shop in summer; the vacuum pump takes care of the heating system in winter.

The main feature is the neatness with which the piping has been put up. There is no leaning one way or the other. The upright pipes are vertical, and the horizontal pipes run true. It is an example of good pipe work.

There were imported into Russia during the first half of 1910, 1,751,000 tons of coal and 187,000 tons of coke. In the corresponding half of 1909 the imports of these fuels were 1,264,000 tons of coal and 163,000 tons of coke, which was a loss over 1908 figures.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Repairing Induction Motors

By R. H. Fenkhausen

Many articles describing the winding of induction motors have appeared from time to time in various technical journals, but most of these articles have been written by men connected with the large electrical manufacturing companies, and consequently have dealt with motor repairs from the manufacturing rather than from the operating point of view.

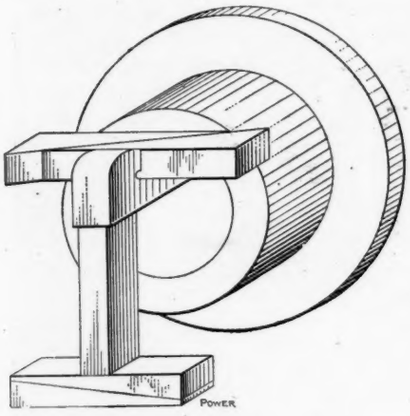


Fig. 1. Drawing a Key

It might appear at first thought that the winding of a motor at the factory and its rewinding in the field are identical operations, but besides the superior facilities available at the factory there are other advantages enjoyed by the factory winder which the field man must get along without. Take, for instance, the so called "basket" form of winding once so popular with all the motor builders, who claimed superior operating characteristics due to its use. This type of winding is largely used at the present time in partially closed slots, the coil being inserted in the slot opening one turn at a time, and the taping applied after the entire coil is in place.

No particular difficulty is encountered by the factory worker in placing these coils. He knows the exact shape required and the proper sequence of operations. The insulating materials are new and flexible and it is easy to bend the coils to make room for the operation of taping, and after the winding is complete the coils are easily shaped without danger of cracking the insulation.

The repair man in the field, on the other hand, is confronted with entirely different conditions. He handles all kinds of windings and does not become skilled in one kind like his factory brother. He must rely on his judgment as to the best way to proceed with an unfamiliar winding and, if he errs, valuable time is lost. The principal difficulty, however, is due to the brittleness of the insulation on the coils, which often defies all attempts at bending without damage. Several coats of varnish are baked on at the factory, and after being in service for a time the insulation of the coils becomes like glass and cracks as soon as any attempt to move the coil is made. The repairing of one coil damages adjacent coils, which must be also repaired, thus damaging still more. This often progresses until a large part of the winding is involved.

The foregoing remarks, though not covering all points of difference, will show that the viewpoint of the manufacturer is not that of the operator, and as evidence of this the type of winding referred to is being gradually abandoned by all motor manufacturers, except for the smallest sizes of machines, because of the difficulty experienced by operating men in making repairs.

In preparing the present article and those which are to follow, the writer has been careful to deal with his subject from the operating engineer's standpoint, and to describe only such processes as may be readily carried out with the tools and appliances available in any motor-driven plant. Many of the "kinks" described may appear simple, but it should not be forgotten that the simplest expedients are often most unfamiliar, and are only evolved from actual experience with far more intricate processes, which are gradually simplified.

Location of Trouble

The first indication of trouble with a motor is usually the appearance of a husky helper, who reports: "The motor in such a shop is burned up." This report need not cause alarm, as any motor trouble, from a blown fuse to a forgotten open switch, is usually diagnosed as a burned-out motor. Upon arriving at the scene of trouble the exact nature of the manifestation of trouble should be ascertained. If the motor was reported as smoking, it is, of course, due to overload or a short-circuit in the winding. If failure to start was the trouble, overload, blown fuses or bad contacts in the starting device should be looked for. The starter should be placed on the starting position and each phase tested for voltage by means of a test lamp.

If no trouble is found in the starter, the load should be removed from the motor by taking off the belt or pinion, and another attempt to start made. An open circuit in one phase will overload the remaining phase or phases and probably cause the motor to smoke. When the open circuit is corrected the motor should run all right. When a motor smokes from overload, it does not necessarily mean that the insulation is charred, because some insulations smoke at a comparatively low temperature and give a valuable danger signal which will save the motor from damage if heeded promptly. After the load has been removed, the motor should be allowed to run until

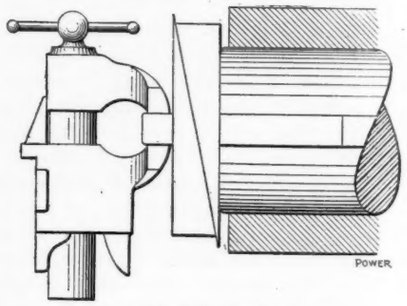


Fig. 2. Pulling a Tight Key

cooled down, as the fans on the rotor will draw cool air into the windings and cool it rapidly. As soon as it is cool the taping of one of the coils should be slit open with a sharp knife and the cotton covering of the wire inspected. If the cotton shows white or is only slightly discolored by the heat, the taping should be replaced and a patch pasted over the cut with shellac.

The earlier forms of induction motor were designed with lots of iron in the magnetic circuit and heating of the iron seldom occurred except as a result of overheated copper. An overload on one of these motors often charred the cotton covering of the wire until short-circuits resulted between turns, without any external appearance of trouble. The later

forms of motors, however, use higher-grade steel and are run at high magnetic densities, so that abnormal conditions usually manifest themselves in excessive iron losses which heat the iron and char the outside insulation of the coils without even discoloring the cotton covering on the wire, so that the coils may be unharmed if the overload is of short duration.

If no overload exists, and the motor is receiving current in all phases, trouble must be sought in the windings. Test for grounds, open circuits and crossed

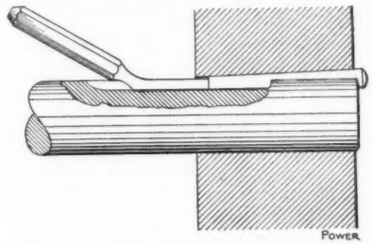


FIG. 3. "DRIFTING" A KEY OUT

phases with a magneto. In a three-phase motor the terminals of the three windings must be disconnected from each other before open or crossed phases can be detected.

WHERE TO MAKE REPAIRS

Every electrical installation should have a clean, well lighted place set aside for the electrical-repair force. A very small place will do, but it should be easily accessible so that motors can be taken there without excessive labor.

Motor winding is clean work and cannot be properly done in a dark and dirty place, so that the time spent in moving the motor to the shop will be more than saved during the winding operation. If forced to make extensive repairs to a motor in place, the repairman will usually do a poor job, and neither the appearance nor the insulation of magnet wire is improved by contact with the grease and dirt existing in some places where motors are necessarily located.

EQUIPMENT FOR HANDLING AND REPAIRING

A half-ton chain tackle hung under a convenient beam will answer most handling equipments, as motors weighing over 1000 pounds seldom give trouble, and when they do, it must usually be repaired in place.

A work bench with a couple of vises, and several pairs of horses complete the really necessary large equipment. A lamp bank, however, will prove very handy for testing, and a good type was described in POWER for May 17, 1910. Another handy piece of apparatus when rush work is to be done is an oven for drying coils. An electric oven which can be adjusted to maintain any one of three temperatures may be obtained for about $25.

The tools required are for the most part those usually owned by electrical workers, but what few special tools are needed can be easily made, and will be described in connection with the work requiring them.

The necessary supplies may be kept in the general store room and issued upon requisition signed by the proper person. The following list will cover most repair work:

Double cotton-covered magnet wire of various sizes;

Woven sleeving to fit magnet wire; two colors;

White muslin tape ½ and ¾ inch wide for taping coils;

Leatheroid or fish paper 1/32 inch thick for coil cells;

Fiber 3/32 inch thick for slot wedges;

"Empire" linen 5 mils thick for cells (also called varnished cambric);

"Empire" linen tape, ¾ inch wide, cut bias;

White adhesive tape, wire solder and soldering paste;

Sheet copper about 1/64 inch thick for stub ends;

No. 22 annealed copper wire for binding joints, etc.;

Orange shellac (with denatured, not wood, alcohol);

Oil- and moisture-repelling varnish, air-drying or baking, depending on whether an oven is available or not.

These supplies represent very little investment, as only enough need be kept on hand to keep the repair force going until more can be obtained.

In case the plant is near a supply house, there is no necessity for keeping a stock on hand, except in large plants where the red tape incidental to getting an order through the purchasing department would cause delay. Even if a full stock of spare coils is carried, the foregoing list of materials is necessary for cells, connections, etc.

DISMANTLING

Upon arrival at the repair shop, the motor must be dismantled. In most cases the pulley or pinion must be removed before the heads can be taken off. If held by set screws, this is a simple matter, but if keyed it is often quite difficult, especially if no gib head is on the key. A gib-head key is usually removed easily by two wedges driven from opposite sides, as shown in Fig. 1, the end of the key being supported from beneath to prevent bending it downward. Very obstinate keys can often be removed by means of a vise from the bench, used to grip the end of the key firmly while wedges are driven between the vise and the pulley, as shown in Fig. 2.

If the key has no head, it is sometimes possible to lay a short key in the keyway back of the key it is desired to remove; then, if the pulley can be driven further on the shaft, the key will be unable to follow it by reason of the short key behind it and it will remain stationary until the pulley is driven back far enough to allow the key to be gripped with the jaws of the vise.

In case there is room back of the pulley or pinion, a key drift may be inserted in the back end of the keyway and the key backed out as indicated in Fig. 3.

If none of the foregoing suggestions will start the key, it must be drilled out, but a gib-head key should always be used to replace it when the motor is reassembled.

After removing the key and pulley and taking off the journal brackets the rotor should be removed from the stator. Great care must be used in removing the rotor, because if the bolts are allowed to strike the stator coils, the insulation is liable to be damaged. The safest plan to follow with a rotor too heavy to be lifted by hand is to block up level with the bottom of the stator bore and slide the rotor out onto the blocking; very heavy rotors should be handled as shown in Fig. 4.

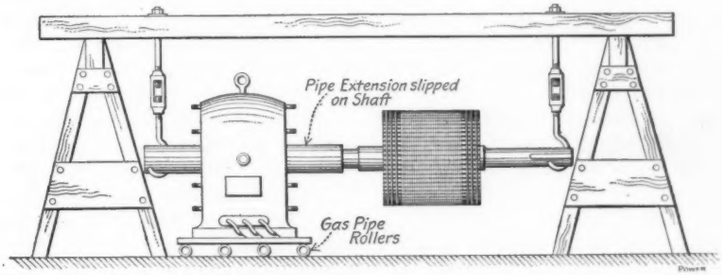


FIG. 4. REMOVING OR REPLACING AN ARMATURE

A helper should be set to work cleaning the stator and rotor thoroughly, first blowing out with an air blast and afterward washing with a rag soaked in gasolene. It is well known that gasolene attacks the varnish on the coils, but the oil and grease cannot be removed any other way, and as all coils should be given a coat of oil, and moisture-proof insulating varnish before the motor is replaced in service, the damage to the old varnish is unimportant.

SHAFT AND BEARINGS

The airgap of an induction motor is made very small as compared to that of a direct-current motor, in order to obtain satisfactory operating characteristics. Consequently, a small amount of wear will allow the rotor to come into contact with the stator, with disastrous re-

sults. It is, therefore, essential that the shaft and bearings be kept in good condition, and while the motor is in the shop advantage should be taken of the opportunity to inspect and overhaul them if necessary.

The shaft should be examined closely, and if scored or grooved it should be turned down to the next smaller thirty-second of an inch in diameter and a record kept of the size, as standard bearing sleeves can no longer be used to replace worn ones. In a large plant it

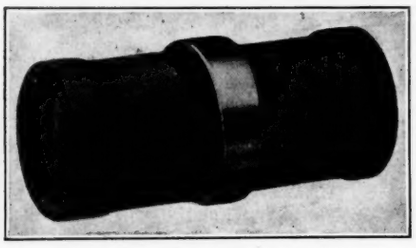


FIG. 5. SOLID JOURNAL SLEEVE

often pays to renew the shaft rather than depart from the standard size. After some years it is sometimes necessary to reduce all shafts, but, of course, a new standard could then be adopted and each motor that comes in for repairs can be changed to the new standard shaft size. If the shaft appears to be all right, its truth should be verified by a test on centers if possible.

The journal boxes should be removed from the heads and the sleeves tried on the shaft, all oil having previously been wiped off so that it will not form a cushion and prevent the detection of slight looseness between the shaft and the sleeve. This method is preferable to calipering, because it gives a closer indication than the average person can obtain with calipers, unless thoroughly experienced in their use. If the sleeve has more than a very slight amount of play

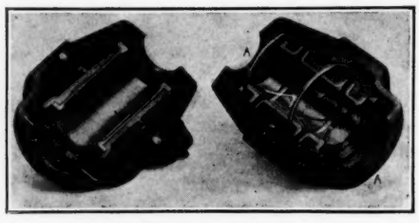


FIG. 6. SPLIT JOURNAL BOXES

it must be renewed, as it will grow rapidly worse because of the unbalanced magnetic pull in the airgap.

Motors of 5 horsepower and smaller usually have solid bronze journal sleeves which must be renewed completely, although in some cases it is possible to reduce them with a bronze bushing kept from turning by a dowel pin. In motors of more than 5 horsepower, cast-iron bearing shells lined with babbitt are commonly used. These are of two types, shown in Figs. 5 and 6.

The plain sleeve type shown in Fig. 5 can be bought complete, with all oil grooves cut and ready to install, for less than the babbitt can be poured by a repairman. For example, the sleeve for a 10-horsepower motor costs but $1.65, while to babbitt the old shell, bore and cut oil grooves in the lining would cost $4 or $5 in most shops, besides the loss of time. Another advantage of buying standard bearings is the interchangeability secured. Many makers bore their bearings several thousandths small and size them by forcing a hardened-steel mandrel through them in a hydraulic press. When the journal on the shaft has been reduced, however, it is impossible to use standard bearings, and the old shells must be relined. Sleeves of the split type, as illustrated in Fig. 6, are many times as expensive as the solid sleeve type and it therefore always pays to reline old shells of this type.

BABBITTING SHELLS

The proper grade of metal must always be used for relining bearings. The manufacturers of the motor will usually supply metal suited to its bearings, as it is to their interest to have their motors stand up well in service. The old metal must first be melted or chipped out, and remelted with a little new metal added. It is essential, however, that the two lots of metal shall be of the same composition. If any doubt exists on this point, the old metal should be discarded and all new metal used, because it frequently happens that two metals, each satisfactory for a given service, will run hot when mixed and ruin a shaft.

Fig. 7 shows how to set up for babbitting a solid sleeve of the type shown in Fig. 5. A mandrel is obtained, of a diameter from ⅛ to ¼ inch smaller than the required bore of the sleeve. This should be tapered if possible to make removal easy, but if freely coated with white lead it should give no trouble. The mandrel should be set up in a vertical position in a hole bored in a board and the sleeve slipped over it. Four wooden blocks should be spaced around the lower end of the mandrel to hold the sleeve concentric with the mandrel. Clay may be filled around blocks to keep babbitt out of the counterbore and the oil-ring grooves filled with thin wood or asbestos, cut out to fit half way around the shaft, as indicated in Fig. 7. This is not essential, but it saves cutting out the grooves in the finished lining and is well worth the trouble. The entire rig should next be heated with a gasolene torch until too hot to touch, in order to avoid chilling the metal before it reaches all parts of the shell, and also to expel any moisture. A very small amount of moisture will generate steam enough to cause a violent explosion when the hot babbitt is poured in.

While the shell is being prepared, a helper should be melting the babbitt in a ladle over a wood fire or a gasolene furnace. When the metal is hot enough to char a pine stick, a few pinches of sal ammoniac should be thrown in. This will cause all the dirt to rise to the top, where it can be skimmed off with a small ladle. Great care must be used to make sure

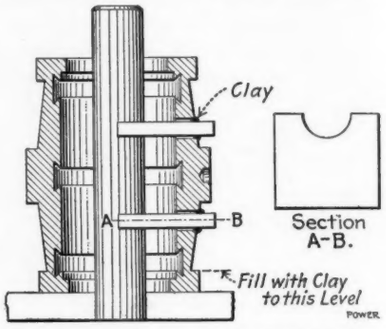


FIG. 7. PREPARATION FOR BABBITTING

that the metal is not overheated, as its anti-friction properties are liable to be seriously impaired.

The metal should be slowly poured into the shell to avoid entrained air and consequent "blow holes" in the casting, and a close watch kept for leaks, which should be promptly plugged with soft fire clay. As it is obviously impossible to peen the metal in a solid sleeve, the worker must take pains in pouring to insure a tight joint with the iron. It is a good idea to tamp the metal into place with a stick while it is still in a plastic

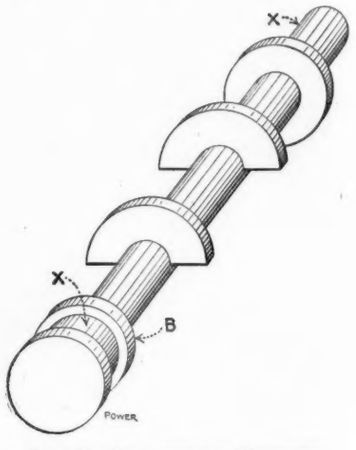


FIG. 8. BABBITTING MANDREL

state, in order to prevent porosity and looseness of fit in the shell.

Split shells, such as shown in Fig. 6, are babbitted one-half at a time in the horizontal position. They are quite difficult to pour, owing to the number of grooves and shoulders that must be cast, but by means of a special mandrel like Fig. 8, which forms all grooves and shoulders without setting up, split bearings are very easy to reline. If the

mandrel is made a good fit at the points *X X*, it may be used to babbitt the sleeve to exact size, because the bores *A A*, Fig. 6, are supposed to be concentric with the shaft, and to serve as guides for the accurate location of the mandrel. The shoulder *B* serves to locate the mandrel longitudinally and govern the end play of the motor shaft. The oil-groove collars embrace only one-half of the circumference of the mandrel; therefore, the lower half of the bearing is cast with the collar side of the mandrel on top. If a lathe is available, it is better to make the mandrel ⅛ inch smaller than the shaft and after the metal has set, it may be peened until all pores in the metal are closed up.

The surplus babbitt must then be chipped off the seam face of the shell, care being used to chip *toward* the iron in order that the metal may not be loosened from the shell. The edges of the babbitt lining should be filed down flush with the iron; the two half shells may then be put together and bored out in a lathe.

As it is rather difficult to true up a

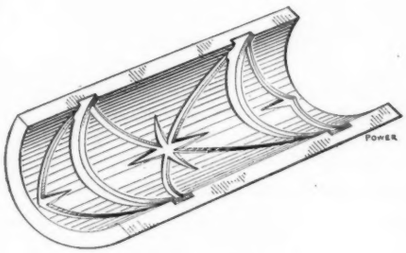


FIG. 9. INEFFECTIVE OIL GROOVES

sleeve of this type, owing to the short length of turned surface exposed when the sleeve is clamped in the lathe chuck, it is better to bolt the sleeve in place in the journal bracket of the motor and chuck the bracket in the lathe. The face of the bracket may be bolted against the faceplate and trued up with the counterbore. If no lathe large enough to swing the bracket is available, it will save time and improve the accuracy of the work if a piece of cast iron from the scrap heap be bored out to fit the outside of the sleeve and the latter held in it by a set screw while being bored. Only a straight bore is required, as all grooves and both faces were formed by the mandrel.

OIL GROOVES

Too much attention cannot be given to the cutting of the oil grooves, as the distribution of the oil and consequently the running temperature of the shaft and bearings are determined by the oil grooves. If the original pattern is not invisible, due to melted babbitt, it should be followed, a sketch of it being made before the old babbitt is removed.

If the old pattern has been obliterated, it should be remembered that oil, like water, does not naturally tend to flow up hill, and the grooving should be designed accordingly. Grooves cut as shown in Fig. 9 are useless; but many "mechanics" will cut grooves in this way. The grooves should start at the ring slot, on the top of the shaft, and curve down

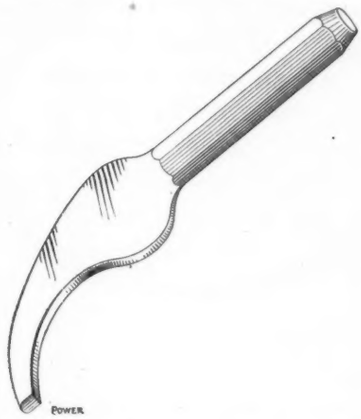


FIG. 10. OIL-GROOVE CHISEL

toward the horizontal center line of the bearing. They should not extend to the end of the sleeve but stop about ¼ inch from the end, to prevent the oil from flowing out at the end of the sleeve. A narrow, round-nose chisel, bent to the curvature of the bearing, as shown in Fig. 10, should be used. Oil grooves should not be cut in the lower half of a sleeve, as it reduces the bearing surface too much; the grooves in the upper half should not be cut any wider than necessary, for the same reason.

A good pattern for the oil grooves of motor bearings equipped with two oil rings each is shown in Fig. 11. It will be noticed that the grooves from opposite rings cross each other; therefore, even if one ring should fail to work, the remaining ring can supply oil to the entire bearing.

After chipping the grooves, the bearing should be carefully scraped with a half-round scraper, to remove any burs formed by the grooving chisel.

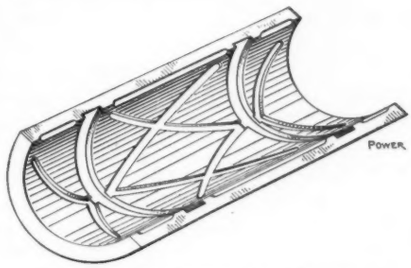


FIG. 11. EFFECTIVE OIL GROOVES

Before reassembling the journal brackets the oil rings should be carefully examined, as they often are bent and twisted accidentally when the bearings are removed.

If the motor is a new one and the bearings have worn out without any apparent cause after a short run, it may be that the condition illustrated in Fig. 12 is responsible. At the factory a superficial examination is made to see that the rings revolve freely, but owing to slight irregularities, unavoidable in a rough casting, it occasionally happens that the rings barely clear the sharp edges *E E* by a hair's breadth. As soon as the bearing wears the least bit—as much as might occur in one day's run—the rings "hang up" on the edges *E E* and the bearing melts out from lack of oil. The remedy is to chamfer off the sharp edges at these points with a file or chisel. This will allow the rings to drop further into the bore, as shown by the dotted lines. (The drop is exaggerated for clearness.)

When replacing the journal brackets on the motor, turn them upside down before slipping the bearings over the shaft. This will allow the rings to drop clear of the bore and avoid the necessity of lifting them with a bent wire while inserting the shaft. After the end of the shaft has passed the rings, the bracket may be turned half a revolution and shoved into position on the stator frame.

The nuts should be uniformly tightened all around the circumference of the bracket ring. If one side is tightened

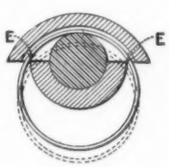


FIG. 12.

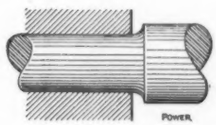


FIG. 13.

very much ahead of the other, the bracket will bind and cannot be drawn into position. The best method is to tighten all the nuts by hand until the bracket is just starting to enter the counterbore all the way around. Two opposite nuts should then be alternately tightened two flats at a time until the bracket is in place. With very large brackets and those which fit very tightly, four nuts should be worked up to avoid springing the bracket. The remaining nuts may then be run up by hand and all nuts given a final turn with the wrench.

After the brackets are in place, the rotor should be tried, and if it does not rotate freely, the brackets should be loosened and the rotor tried again. If it turns freely, the trouble is due either to poor alinement or lack of end play. Poor alinement seldom occurs, as self-alining seats are used on most bearing sleeves. Lack of end play may be corrected by moving the bearing shells outward in the housing, if means for adjustment is provided. Where no adjustment is possible, the sleeve must be faced off. End play of the motor shaft is often prevented by the entrance to the bore of the bearing sleeve not being flared enough to take the fillet on the shaft; Fig. 13 illustrates this condition.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Splash Lubrication

By James H. Beattie

A great deal of difficulty is experienced by operators of small vertical gas engines depending on splash lubrication, due to heating of the crank shafts and wrist-pin bearings. The trouble in nearly all cases is due to the lack of sufficient care in renewing the crank-case oil from time to time. It is not sufficient merely to add to the oil in the crank case as it is used up; the old oil must be removed and the crank case cleaned thoroughly and refilled with new oil. The frequency with which this should be done varies with conditions, but in no case should it be allowed to go more than a few weeks without attention. Any engine depending on splash lubrication is subject to this trouble, but the smaller sizes, ranging from about 2 to 10 or 12 horsepower, suffer particularly, as these sizes are commonly used by farmers and contractors under conditions where the amount of attention given is very small.

It has always seemed to the writer that splash lubrication is wrong in principle. The oil is used over and over again, gradually becoming mixed with particles of metal from the bearings and other forms of grit. It has been my experience that bearings lubricated in this manner wear much faster than bearings supplied by sight-feed lubricators feeding pure oil.

One of the most alluring points claimed for splash lubrication is that it is absolutely automatic and requires very little attention. On the contrary, it is rather uncertain and requires very careful and systematic attention in order to prevent serious trouble, as just pointed out. The following experience is a typical one: In cleaning the crank case of a splash-lubricated engine, a small piece of waste was accidentally left in the oil reservoir. The oil hook on the connecting rod picked it up and soon stirred up so much grit by sweeping the bottom of the reservoir at each revolution of the crank that a hot bearing resulted.

What is even worse than the excessive wear on the bearings is the excessive wear imposed on the cylinder and piston through lubrication with grit-laden oil. Another and a very serious objection to splash lubrication is the fact that it is almost impossible to keep the oil in the crank case from working out through the bearings, spreading over the frame and flywheels and making a mess of the whole engine. The writer has never yet had the pleasure of seeing an engine depending on splash lubrication which was entirely free from this fault.

It seems evident that it would be vastly better to equip the cylinder and bearings with sight-feed oilers than to depend on splash feed. The advantages are so obvious that it is not necessary to mention them all, but the chief one is that the oil after passing once through the bearings is filtered before being used in them again, or else used for other and less important purposes.

What Caused the Freak Diagrams?

By S. W. Rushmore

The three indicator diagrams reproduced here were taken a few minutes apart from my 140-horsepower single-cylinder producer-gas engine. Immediately after taking the normal card, at the full rated load of the engine, the engine began to behave badly, and, while maintaining the full dynamo load of about 750 amperes, we got the two freak diagrams shown in Figs. 2 and 3.

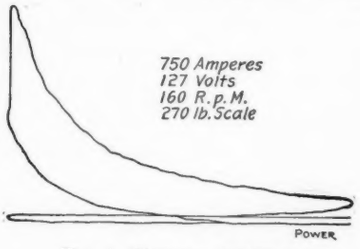


Fig. 1. Normal Diagram

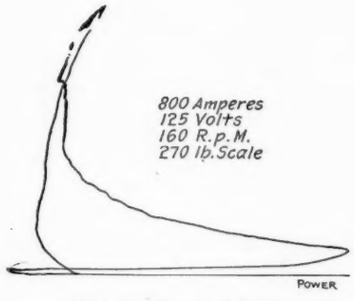


Fig. 2. First Freak

Although the engine was carrying practically full load at the instant diagram No. 3 was taken, it is evident that the power was supplied chiefly by the flywheel. Perhaps some of the readers of Power can explain the freak diagrams, in the taking of which the indicator was handled in exactly the same manner as when taking the normal diagram of Fig. 1.

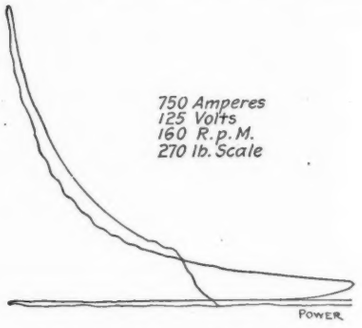


Fig. 3. Second Freak

Gas Poisoning

By J. O. Benefiel

In the issue of January 24 there was an interesting account of an engineer's experience with carbon-monoxide poisoning. I have had some experience along that line, being in charge of a scrubbed-gas plant of 4000 horsepower capacity.

We have had quite a number of the men overcome with the gas, but none fatally; they usually have a severe headache the rest of the day, but otherwise there do not seem to be any ill effects. Of course, the results would be fatal if the man were exposed to the gas long enough.

The gas does not seem to act gradually; apparently, one may get loaded with it before it begins to act, then the loss of consciousness seems to take place almost instantaneously. A man seldom gets a heavy charge of it the second time; in fact, we have had no one get a stronger dose the second time than he could walk away with.

The symptoms are a slightly increased rate of breathing and heart action, which will pass unnoticed by the inexperienced. Stepping into the cold air will cause it to take effect instantly.

One does not realize that one is losing consciousness, and this makes it very dangerous, especially when the workman is overhead. I had one man lose con-

sciousness just as he was starting down a 25-foot ladder. Fortunately, two men were working together and the man on the platform dragged the poisoned man back just in time to prevent him from having a bad fall. In another case a man was working on a ladder when his senses left him, but there was a man just below him who carried him down.

The gas does not seem so effective before being cleaned. The generator men are exposed to it all day long on the charging floor and they suffer from nausea only; it is often so bad as to cause vomiting, but not dizziness or loss of the senses. It does not seem to affect the general health; some of the men have been doing this kind of work two years and are in good health.

When a workman is overcome by producer gas he should be carried to a place where the air is pure and *warm;* exposure to cold is to be avoided. There should be an oxygen outfit at hand and the oxygen should be administered at the earliest possible moment. The efforts of a physician are feeble as compared with the oxygen treatment. An oxygen outfit is not expensive; we keep two tanks on hand to avoid the liability to run short in case more than one man should be affected at the same time. A stiff drink of whisky is beneficial after the patient has regained consciousness, and he should not be allowed to go out of doors or to start home alone until he has fully recovered. We always have a doctor to attend a man who has been gas-poisoned, chiefly because the man might have a bad heart which would need the attention of a physician. Incidentally, it would clear the management of any charge of neglect in case of serious results.

Sometimes artificial respiration should be resorted to if the patient's breathing seems to be weak.

In the two years we have been using producer gas we have had only six men get knocked out, though we have had the men get a light dose often. Two pipefitters were working overhead on a plank runway one night and both of them got so weak and dizzy they could not get down; they had to lie on the runway until they recovered, there being no one else about.

LETTERS

Is This Speed Practical?

I shall appreciate expressions of opinion from POWER readers on the following question:

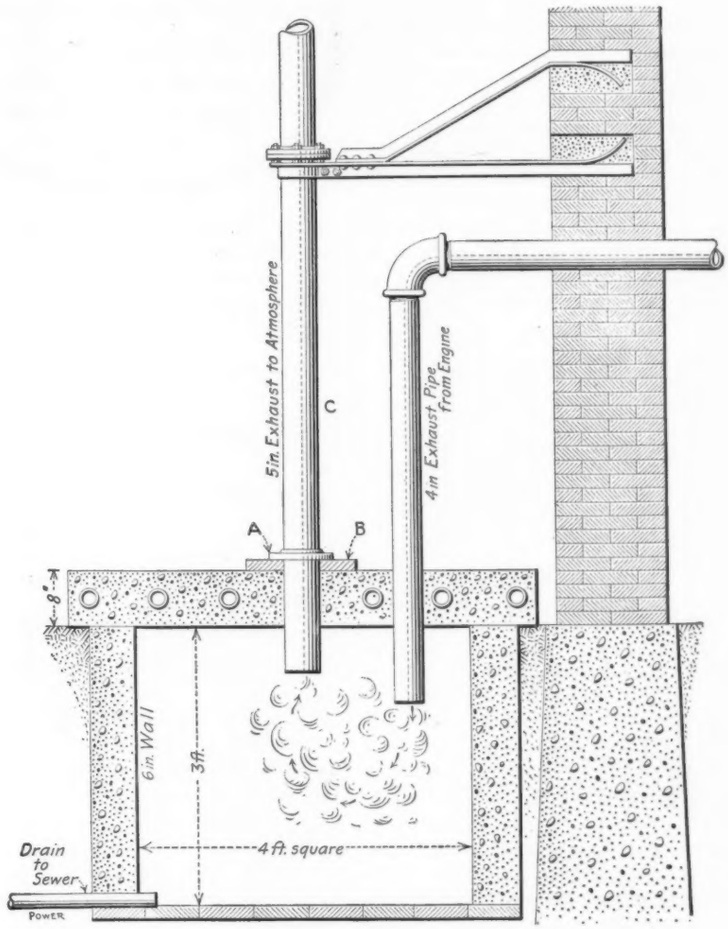
Is a rate of speed of 300 revolutions per minute too high for a vertical engine of 9½ inches bore and 12 inches stroke, with a connecting rod 30 inches long? The engine is single-acting but is built with a crosshead instead of the usual trunk piston and gudgeon pin. It is lubricated by splash from the crank case.

O. J. BARKER.

Cameron, W. Va.

A Homemade Muffling Box

The accompanying sketch shows the construction of a muffling pit which we have found very satisfactory. The pit is just outside of the engine-room wall and is 3 feet deep and 4 feet square. The walls are of concrete, 6 inches thick, and the cover is 8 inches thick and reinforced with old boiler tubes to stiffen it up. The pipe carrying the exhaust gases away from the pit is 5 inches nominal diameter; a 1-inch collar is shrunk on the pipe at *A* and this rests on a 15-inch plate *B*. The pipe *C* is braced to the building wall, as shown. When pouring the cover we put short pieces of pipe in place of the intake and outlet pipes and left them there until the cement had dried.



A CONCRETE MUFFLING BOX

This has muffled the exhaust so that the report is not as loud as that of a non-condensing steam engine exhausting to the atmosphere; in fact, it can hardly be heard when standing near the pipe.

The engine is a three-cylinder, vertical, with cylinders 12x12, rated at 100 horsepower when running at 275 revolutions per minute on natural gas of about 950 B.t.u. per cubic foot.

The first muffler was put in over a year ago and has given such thorough satisfaction that the other engines were provided with mufflers of the same construction. Of course, several engines can exhaust into the same pit if the pit be made larger; the one here illustrated is about the right size for an engine of 125 horsepower.

M. W. UTZ.

Minster, O.

The briquetting industry in several European countries has made rapid advances within the past few years, the production last year in Germany alone amounting to eighteen million tons. This is due partly to the fact that the coal in these countries runs in thinner veins, limiting the supply of the larger sizes, and also that cheap labor makes it possible to use dust which would otherwise be discarded. The popularity of this form of fuel is shown by the fact that thirty per cent. of the total coal consumed in Berlin is in the form of briquets.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Repairing a Wrecked Engine

A short time ago I had a repair job on a 20 and 36 by 48-inch cross-compound engine. The low-pressure cylinder took water on the head end and forced the front of the pillow block off, as shown in Fig. 1, also breaking the cap, and before the engine could be stopped the shaft had been thrown out of alinement so that the 50-inch belt ran off the pulley so far that it got up against the foundations and ripped one edge open about 3 inches, for its entire length. The belt was taken off and repaired, and in the meantime four 1¼-inch holes were drilled and tapped in the broken pillow block, and clearance holes drilled in the broken piece, which was fastened to the main casting by means of bolts, as shown. An 8x8 timber was placed from the wall to the pillow block and in place of the cap two 2½x1-inch wrought-iron straps were used to further strengthen the block. Then the low-pressure side was disconnected and the engine ran a part of the plant until a new pillow block arrived.

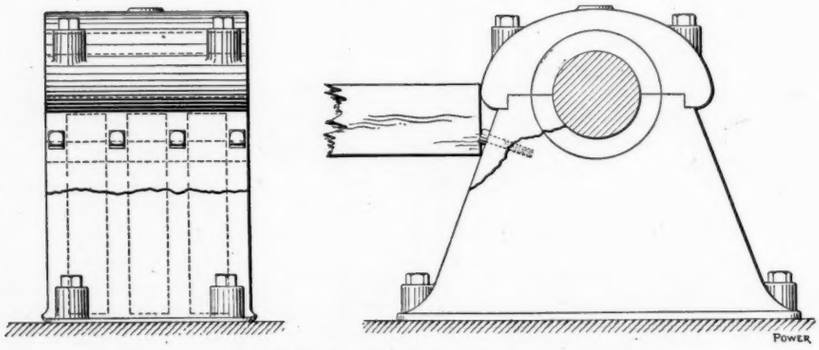


FIG. 1. HOW THE PILLOW BLOCK WAS REPAIRED

The shock received by the crank sheared the key about 1/16 inch on the shaft so that it had an offset, making it advisable to take off the crank and put in another. When the new crank arrived, the engine builders sent a man to assist in taking off the old crank and to put the new one on. He intended to work all night, with a ratchet, drilling holes in the crank to break it off. I suggested taking a headstock from one of the lathes in the machine shop and blocking it up level with the center of the crank shaft, and with a drill chuck in place and a jack screw between the wall and the headstock for a feed, using a small 6-horsepower engine to drive the same. It took 90 minutes to remove the crank, which was 7 inches thick. Fig. 2 shows the method of drilling the crank. A 12-inch face driving pulley was used, and as the lathe head was moved nearer the driving engine, the belt was put up on the next cone so that the belt had to be taken up but twice during the operation. After the holes were drilled in the crank disk, tapered pins were driven in them which split the crank disk along the row of holes, when the new crank was put in place. The new pillow block was then made secure, and after adjustment the job was completed.

All preparations were made, such as getting the drilling apparatus, engine and lathe headstock ready during the day while the plant was running, so that no time was lost in getting to work after shutting down.

L. R. CORM.

Boston, Mass.

Slipping Latch Blocks

In a certain power station, considerable trouble and annoyance were experienced with the latch block slipping or failing to open the valve. This caused the engine to take steam on but one end, causing surges and cross currents between the alternators, which affected the most distant substation. Sometimes the slipping would be so bad that the engine would have to be cut out of service until the latch block could be changed.

As a remedy it was decided to make some latch plates of Novo steel, a very fine, hard grade of tool steel. The first effort was a failure, owing to the fact that the plates were not hardened sufficiently in tempering.

A second trial, however, produced plates that have been in continuous service for five months without being disturbed and still show no sign of wear, and have not once failed to open the valve. This steel must be annealed before working, which is done as follows: Cut it into pieces of approximately the size of the plates. The pieces should be buried in lime in a length of iron pipe, of sufficient size to hold them, and the ends capped. A hole should be drilled in one cap to let out moisture, etc. The whole is then placed in a slow fire and gradually heated until the pipe begins to take on a welding heat. The fire should then be covered with coal and

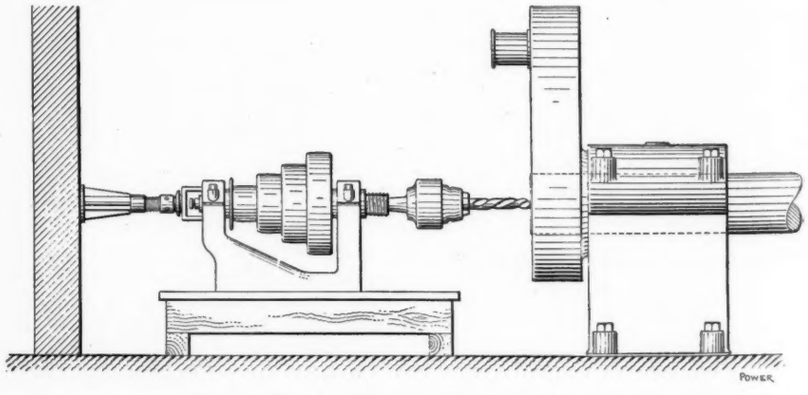


FIG. 2. METHOD USED IN DRILLING CRANK

left undisturbed until the steel has cooled, after which it may be worked into the desired shape for the plates. After finishing, the plates must be tempered by heating to a *bright red* and plunged into oil. This steel is expensive, costing about one dollar per pound, but considering the wear secured the cost is trifling.

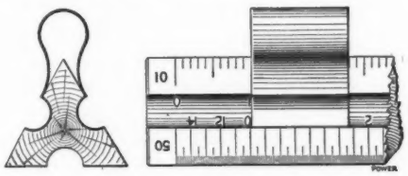
By buying the steel in bars of the proper width and thickness it is a comparatively easy matter to make any ordinary latch plate. The steel may be bought annealed but it may still be too hard to work well.

C. L. GREER.

Handley, Tex.

Boxwood Scale Holder

A device for protecting a boxwood scale is illustrated in the sketch shown herewith. It also serves as a holder for the scale, and prevents its being soiled.



HOLDER ON SCALE

The holder is made of 1/32-inch spring-sheet brass and fits snugly to the scale.

C. T. SCHAEFER.

St. Louis, Mo.

Gage Pipe Froze

The night breezes without registered a temperature of 20 degrees Fahrenheit and everything was lovely, so to speak. No. 3 was working connected with Nos. 1 and 2 boilers, all being 125 horsepower and of the horizontal return-tubular type. Suddenly, No. 3 gage registered a pressure of 135 pounds, but Nos. 1 and 2 gages remained normal at 90 pounds per square inch.

I began investigating, and the safety valve convinced me that the gage, and not the boiler was at fault. I soon found that the 3/8-inch line to the gage had frozen, due to some person neglecting to close a window nearby, and the expansion of ice, together with the noncompressibility of water, caused an increase of 45 pounds pressure on the gage over that carried on the boiler.

This incident demonstrated three important facts; first, the incompressibility of water; second, the expansive force of ice, and third, pressure created by freezing water will release itself along the lines of least resistance.

I am none the worse for my experience, although the first discovery of the increased gage pressure gave me a "jolt" for a moment.

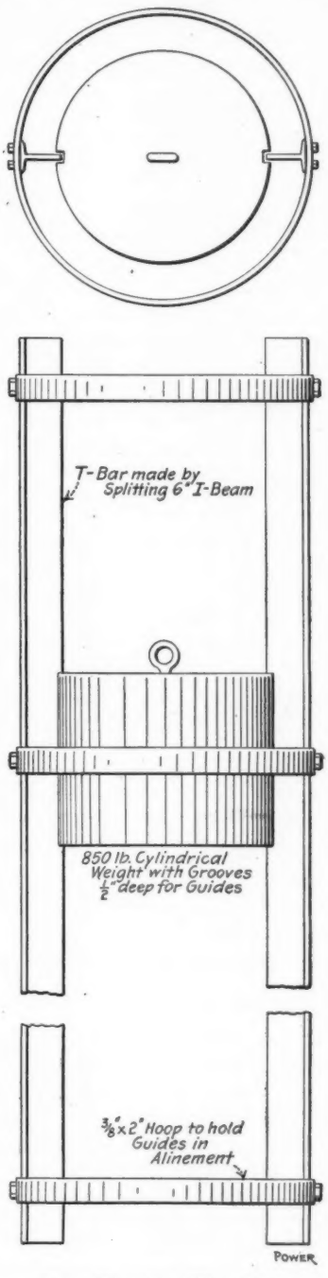
L. E. KENNEY.

New York City.

Removing a Piston Rod

The accompanying illustration shows a device used to force the piston rod out of the piston of an old blowing engine.

One of the valves in the top cylinder head of the air tub broke and a piece fell into the clearance space. The result was that the piston rod was jammed


T-Bar made by Splitting 6" I-Beam
850 lb. Cylindrical Weight with Grooves ½" deep for Guides
3/8"x2" Hoop to hold Guides in Alinement
POWER

HOW HAMMER WAS USED

¼ inch through the piston. The question then was how to remove the rod. It was suggested that the piston be blocked up and a weight dropped on the protruding portion of the rod.

A pair of guides for the falling weight were made from a 6-inch I-beam, 15 feet long, which was mounted on a planer and cut into two T-bars by splitting it down the middle with a cutting-off tool. The guides were held in proper alinement by hoops made of 3/8x2-inch flat bar iron, as shown in the sketch.

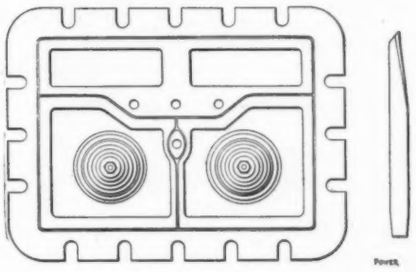
This rig was hoisted into place and lashed in position. The piston was blocked up on four blocks set so as to bring the stress of the blow on the four legs of the *A* frames. The rod was disconnected and the crosshead moved down. The weight was hoisted 10 feet and one blow did the work.

J. J. O'BRIEN.

Buffalo, N. Y.

Lead Fuse Gasket

I have had a great deal of trouble keeping sheet packing between the suction valve plate and the discharge valve plate of an old tank pump. When a soft sheet packing was used it would blow out, and if it was stiff and strong enough to withstand being blown out, the water



GROOVED PLATE

and air would be forced between the gasket and casting.

After experimenting with several styles of sheet packing, I had a grooving chisel made as shown in the sketch, which would make a groove with about 3/32-inch radius.

The plate was grooved as shown. Then I got some electricians' lead fuse, which was the only kind available, and made an endless gasket by soldering all ends, and this lead-wire gasket was a success.

B. T. HAWLEY.

Starkville, Colo.

Crosshead Pound

A disagreeable knock at the crosshead of an 18x36-inch Corliss engine puzzled me for some time until I discovered that it was caused by a sidewise movement of the rod brasses on the crosshead pin. There was but little clearance between the brasses and the crosshead, yet there was enough to allow it to slap at the end of the stroke.

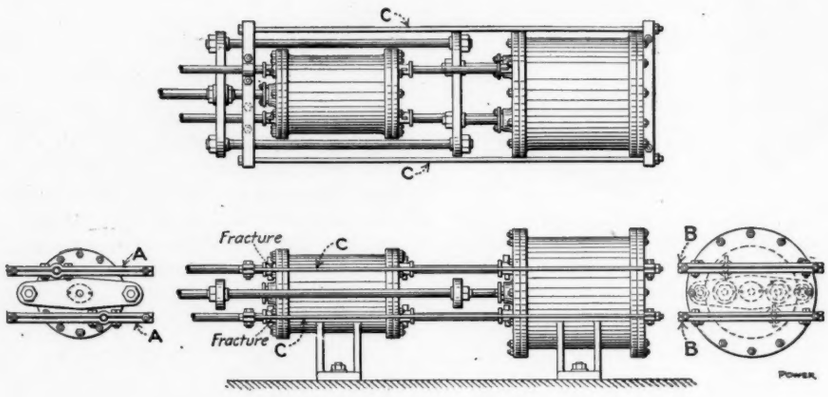
Efforts to remedy the trouble by means of washers, etc., were unsuccessful, but I finally gave one side of the brasses a thin coat of solder and dressed it down with a file until it made an easy fit in the crosshead. The knock then disappeared.

L. MANN.

Ware, Mass.

Wrecked Steam Pump

During a recent visit to the steam plant of a friend, he showed me one of the large duplex tandem-compound pumps which had clamps and rods applied to hold the steam and water ends together, as shown in the figure. The low-pressure piston had two piston rods which ran along the high-pressure cylinder, one on each side diametrically opposite, and



DETAILS OF PUMP REPAIR

were fastened to a crosshead on the high-pressure piston rod which was also the plunger rod for the water end, as the steam piston rod and the plunger rod were one piece, carrying on one end the steam pistons and on the other end the plunger, with a crosshead in the center of the rod between the steam and water ends. One of the piston rods in the low-pressure cylinder became disengaged on the forward stroke, but the other remained fast. This tipped the piston in such a manner that when the pump started on the back stroke the low-pressure piston moved in jerks. Several of these jerks were enough to tear the steam end from the stayrods between the water and steam ends, the fracture occurring in the sockets on the high-pressure cylinder, into which the ends of the stayrods were keyed, as shown in the upper view. The piston rods, bell crank on the vacuum pumps, and the valve rod were twisted, bent or broken when the steam end started to back off from its foundation. The water ends only are anchored to their foundations as the steam ends ride on iron plates laid on foundations to allow for a slight movement of the steam end to adjust itself to the strain on the rods between the steam and water ends.

The engineer had two clamps made as shown at *A* and two as shown at *B*. The first set were clamped to the stayrods between the steam and water ends, snug up against the parts of the sockets which remained on the rods with the keys left in place. Long bolts with a head on one end and a long thread and heavy nuts on the other end were inserted through the set of clamps on the stayrods and through another set of clamps across the low-pressure cylinder head, as shown at *C*. Nuts were then run on and all drawn up even until the fractures closed tight. The bolts on the side of the greatest strain were made of heavier rods. The strain on the bolt in the clamp on the upper left stayrod is greater than on the bolt in the other end of the same clamp. The same applies *vice versa* on the lower clamp in the same figure. The pump handles just as much water now as it did before the breakdown, but its appearance is spoiled.

This breakdown was caused by an engineer with a "pull" and illustrates how such an engineer can be an expensive man. There certainly must have been a warning sound before the breakdown occurred, which an engineer of real merit would have heeded and have stopped the pump in time to prevent the accident. At the time the pump was running about twenty strokes per minute.

LOUIS T. WATRY.

Pueblo, Colo.

Dynamite in the Coal

I am in charge of a battery of seven water-tube boilers equipped with mechanical stokers. A few days ago one of the firemen brought me a piece of dynamite about 4 inches long that the coal wheeler had found in the coal. Instructions were given to be very particular and examine every shovelful of coal, and it was not long before he found two more pieces of dynamite, one about 3 inches and another about 1¼ inches long. The dynamite was frozen when found, but if it had got into the fire, there would have been an explosion, and a good many people would naturally have said the boilers were dry, or this, that and the other thing.

I have had charge of boilers for about twelve years and have always been very careful to avoid accidents, but that would not have amounted to anything if the dynamite had got into the furnace. I have wondered a good many times since if any of the boiler explosions that occur from no apparent reason have been caused by dynamite. I have found caps in the coal several times, but I have never found dynamite before.

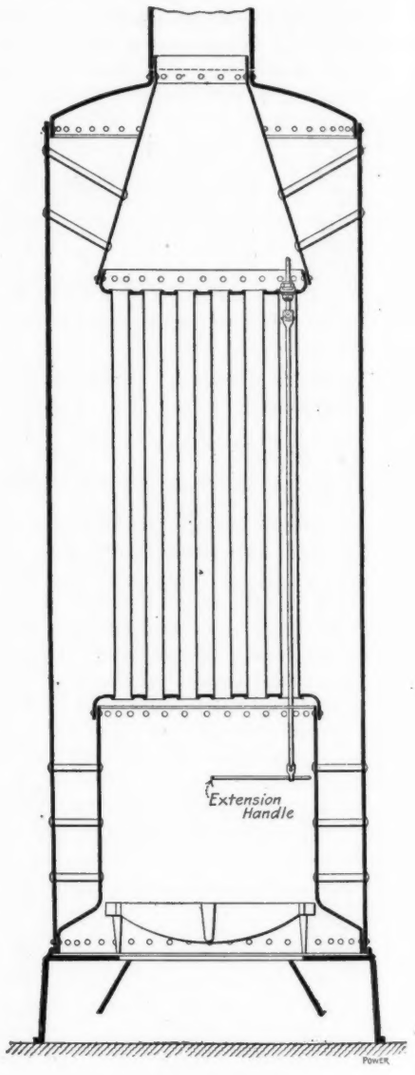
JOHN R. DIXON.

Peace Dale, R. I.

Using a Tube Expander

Recently, while putting new tubes in an upright submerged-flue boiler, I had to devise some means of rolling the outside tubes on the top end, as the pitch of the cone was such as to make it impossible to put the roller in that end.

The accompanying illustration shows



EXPANDER IN TUBE

the roller slipped in from the bottom end after that part of the roller which rests against the outside of sheet had been removed. This did the job very nicely and very little difficulty was experienced in keeping the roller in place and turning the extension rod from below.

WILLIAM I. MORGAN.

Augusta, Mont.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Exhaust Steam in Low Pressure Turbines

In the January 31 issue, Mr. Fenno, while attempting to prove that the statements in a certain turbine catalog are misleading, neglected to take into account an important factor in the steam-engine cycle—that of reëvaporation—and by so doing rendered his analysis more misleading than the original which he was trying to disprove.

The original statement was to the effect that a pound of dry steam expanding adiabatically from 150 pounds gage to atmospheric pressure, gives up, in work done, approximately the same number of heat units as a pound of dry steam expanding from atmospheric pressure to 28 inches of vacuum, the inference from this being that an exhaust-steam turbine working between the lower pressures would do as much work as a reciprocating engine working between the upper pressures. Mr. Fenno showed that dry steam expanding adiabatically from 150 pounds gage to atmospheric pressure would have a final quality of 85.7 per cent., which in actual practice would be further decreased by cylinder condensation and radiation; hence, the low-pressure turbine would not receive dry steam, but instead steam only 85.7 per cent. dry, at the most. If a separator were used between the engine and the turbine this would mean that the latter would use only 0.857 pound of dry steam for every pound used by the former.

Theoretically, this is true, but practically it is not. Condensation will take place in the early part of the stroke, but at some point between cutoff and release the temperature corresponding to the pressure of the steam will fall below that of the cylinder walls and reëvaporation will set in. This, although not very large at first, is greatest near the end of the stroke; but the instant the exhaust port opens there is a considerable drop in pressure (with a corresponding drop in temperature) accompanied by a rapid reevaporation, and the exhaust steam will leave the engine very nearly dry. The application of Hirns' analysis to an engine test will show this plainly. The heat regained during the reëvaporation adds little to the work done in the cylinder but it would be available in a low-pressure turbine, and the original statements are not so misleading after all.

A. DE GROOT.

New York City.

Changing the Throttle

Speaking about the best position of the throttle valve, why not change it if the position in which the erecting engineer left it does not suit? Why continue from year to year to leave it in front of the cylinder, flywheel, governor or valve gear, when you know that on the other side, upstairs or below the floor would be better? Several times you have

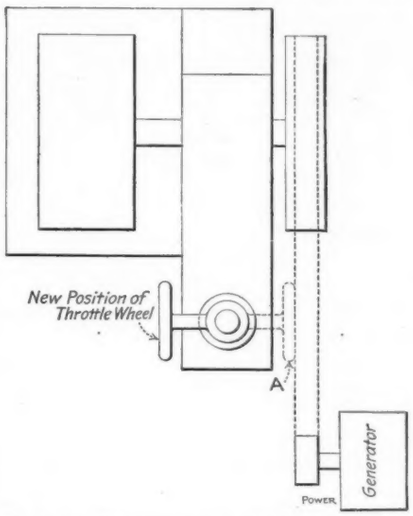


DIAGRAM SHOWING CHANGE IN POSITION OF THROTTLE

ducked from the firing line, wished for better things and let it go at that.

I am reminded of a case where the engineer of a plant in a large department store reversed the throttle as a temporary expedient and became so tickled with the handiness of the new location that he made the change permanent. He also changed the throttle on the duplicate unit, for if one was good, two were better.

There came an emergency call one day for special lighting in a neighboring building where the steam plant had a breakdown. A small generator was borrowed and belted from the flywheel. The only thing that could be done was to fasten the generator to the floor near the head end of the cylinder, thus running the belt across the throttle wheel, as indicated at *A* in the accompanying diagram. This made the symptoms of trouble so acute that a decision was made to reverse the throttle instanter. The pipe flanges being symmetrical, the trick proved so easy that the engineer wondered why he had not made the change before. His memory also carried him back through the long years spent in other plants where throttles and other things made operation unhandy, not to mention occasional flashes of unsafety. The erecting fellow had happened to put things together so and so, and it had never occurred to him as operating engineer to make any changes.

F. WEBSTER.

Scranton, Penn.

Liquid Discharging Device

Mr. Seibert's article in the January 10 issue seems to imply that I have made use of his idea in the design of my device and also that the device in itself is a dangerous one to use.

In answer I would say that the device is entirely my own idea, and while Mr. Seibert may have had the same idea, he failed to protect it with a patent.

The principle on which the device works is old and not patentable, but the combination is new and I hold the patent.

I do not recommend the use of over 20 pounds pressure, and every purchaser is cautioned against anything in excess of this in wooden barrels, unless the heads are clamped.

It is immaterial to me how this pressure is obtained, whether by maintaining a receiver or boiler pressure of only 20 pounds or by using a reducing valve to step down from a higher pressure. I can do the trick nicely with no other apparatus than a common globe valve between the high-pressure line and the device and anyone else can do the same by using a little judgment.

While an opening 0.03 of an inch in diameter, as Mr. Seibert used, might not maintain an overpressure in the barrel with 80 pounds primary pressure and a light grade of oil, it can easily be seen that it would and did give an overpressure while discharging a heavier grade of oil.

If anyone has any liquids to remove that 20 pounds will not push out, I think that such liquids are approaching the state of solids and that it might be best to knock in the head of the barrel and use a paddle or a spade.

Mr. Seibert's experience proves that the device was not at fault, but the operator.

EARL PAGETT.

Coffeyville, Kan.

Beading Boiler Flues

In reply to L. Earle Brown's inquiry in the December 13 issue about beading flues, the following is submitted from experience gained in practical work as a boilermaker in marine, locomotive and stationary work:

The beading should be put down close to the head until the sheet is nearly nicked by the beading tool. The flues will hold better and last longer because there is less metal exposed to the hot gases and, being tight against the head, there will be less difference in temperature between the sheet and the head and in consequence less difference in expansion and contraction. It is this difference in expansion that causes the flues to leak.

I would like to add a few words here about renewing and repairing flues that are leaking, especially about the use of expanders. It would surprise anyone who had not had years of experience to learn how little expanding is needed to make a tight job and a lasting one.

The majority of engineers always instruct the repair men to expand the flues well, and if he is a boilermaker from a contract shop he will follow instructions with the result that the flues are rolled so thin that the next thing in order is a new set of flues and the contract shop has another order on hand.

When the flues leak, the beading tool only should be used, as it will do all the expanding necessary and not split the bead. If the flue is loose in the head, of course the expander will have to be used.

WILLIAM BEATON.

Gold Roads, Ariz.

Treatment of Subordinates

A great deal has been said recently in the columns of POWER concerning the manner of treating subordinates and I desire to give my views on the matter.

I can heartily indorse Mr. McGahey's letter in the January 24 issue, for I know him personally and have worked for him and his brothers for six or seven years. He practises what he preaches.

I have been a chief engineer for the last four years. I find that by giving fair treatment I can get better results from my assistants than otherwise.

Rightly educated and treated, an assistant can and will save his superior much trouble and annoyance.

I find that the man who must be continually hammered at and driven is practically worthless. The sooner such a man is weeded out, the better for all concerned.

DAVID M. GROVE.

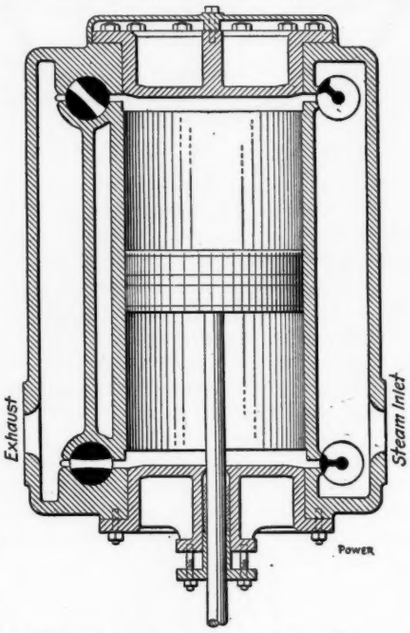
Covington, Ky.

Water Wrecked Cylinder

In the January 17 issue, Mr. Sheehan tells of the wreck of an 18 and 36 by 36-inch compound-condensing Corliss engine.

The cause given is that the valve failed to open on account of the hook blocks being worn, the valve remaining closed long enough for the steam chest to fill with water. When the valve was made to open, this water passed into the cylinder and caused the wreck.

If this statement is correct, it behooves all engineers in charge of vertical Corliss



CHANGE IN LOCATION OF STEAM AND EXHAUST OPENINGS

engines to take notice, for they all might meet with the same trouble.

Why, if there is danger of wrecking an engine in the manner stated by Mr. Sheehan, do not builders design the steam and exhaust connections as shown in the accompanying figure?

A. W. GRISWOLD.

Adams, Mass.

Federal Laws

In the issue of January 10 is an article on Federal license laws by A. A. Blanchard. I believe this article to be a good one and indorse Mr. Blanchard in trying to expand a good thing by which every engineer in the United States would be benefited. I am with him in this great movement and will do all that I can and use my influence with others to help in this great cause; the protection and conservation of life and property.

But stop—and think! Are we getting good results with the present license law in Ohio?

Do you know it to be a fact that politics plays a great part with this law and its enforcement?

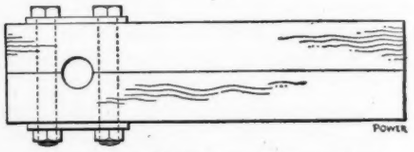
Study your law! Watch its enforcement. The robe of the license examiner is too precious a garment to hand out to any political machine or system. What we need and want is efficiency from the men who secure license. And we *must* have it or else we decay. The examiners themselves should be examined as to their ability in order that when they get a violation they may not always be outgeneraled or defeated to the carelessly concealed mirth of the violators.

ORRIN C. WERNER.

Kent, O.

Piston Rod Clamp

In the Jan. 3 issue, Alfred Woolcock described a piston-rod clamp. I have used the one shown herewith for a number of years; I think it is superior and easier to make.



HARDWOOD CLAMP FOR PISTON ROD

Take two pieces of hard wood 2 inches square by 12 to 16 inches long and bolt them together as shown, using either washers or a plate under the heads and nuts. Then drill a hole the size of the rod, or a trifle smaller, through the wood. Should the hole be too large, so as not to clamp tightly, a thickness of paper may be wrapped around rod.

I have never yet had this clamp slip or mar the rod.

G. A. RAND.

Freeport, Ill.

Arrangement of Boiler Feed Pipes

A great deal of useful information has appeared in POWER as to the proper point at which to enter the feed water to the boiler. My experience leads me to believe that the layout of the plant should be taken into consideration, also the nature of the feed water.

Water that contains sulphates of lime and magnesia will form a hard scale, and if not put through a process of purification before entering the boiler, will form scale in the boiler when the steam pressure is above 50 pounds. With this kind of water little or no trouble would be met with in circulating it through pipes in the boiler before discharging. But with water that contained carbonates of lime and magnesia considerable trouble would be experienced in keeping the feed pipes clear, as the carbonates precipitate at a temperature of from 190 to 212 degrees. With water containing carbonates, my idea is to get the water into the boiler as soon as possible after leaving the feed pump.

W. G. WALTERS.

Stratford, Ont.

Economic Engineering

I noted with interest Mr. Allison's criticism in the January 17 issue of my views in regard to the economic engineer and the superintendent or chief engineer.

I offered no criticism whatever of the economic engineer, neither did I express the opinion that he had not "come to stay." On the contrary, I think that the inefficiency of a good many superintendents and chief engineers has made the economic engineer a necessity, and I do not doubt for a minute that he has come to stay. But, this does not necessarily prove the inefficiency of everybody else.

Mr. Allison does not mention the chief engineer in his criticism, but deals entirely with the superintendent and regards him as the head of a business organization. Looking at the matter from that point of view, I agree heartily with Mr. Allison's views on the subject, but by referring to the editorial in the September 27 issue and also to my "argument" in the November 22 issue, it will be seen that both the superintendent and the chief engineer are considered. I understood the term "superintendent" to refer to the man who superintends the operation of the power plant, and not to the head of a business organization; sometimes he is called the superintendent and sometimes the chief engineer, and sometimes, in the case of a large plant, both are in evidence. If I understand rightly, the manager is considered the head of the organization.

Looking at the matter in this light, I still contend that the man who is "onto his job," I mean by this the man who knows his job as he ought to know it (I did not say "the man on the job"), should be just as efficient as the economic engineer.

Mr. Allison, because he considers the superintendent as an employer, accuses me of contradicting my statements by saying that I had found a great deal more unwillingness on the part of employers to furnish new equipment with which to improve the methods of operation, than unwillingness on the part of the operators to break away from old established customs.

To be sure, the superintendent is usually considered as an employer, so is the section boss on a railroad, but it does not necessarily follow that either has the power to purchase new equipment. This is generally up to the manager, who is also an employer.

A man's title does not necessarily make him more efficient than another man. The most efficient man is the one who does the job right, regardless of his title.

R. L. RAYBURN.

Kansas City, Mo.

Introducing Solvents into Boilers

I read with interest Mr. Taylor's letter in the December 6 issue on the above subject. In the plant where I am employed there is an arrangement for feeding solvents into the boilers which is similar to that described by him, but I never use it except just before washing out. There is a ¼-inch pipe which connects the feed-pump suction line to a barrel on the roof. The solvent is ordinarily placed in this barrel and fed through the small pipe at a rate which is regulated so that three-quarters of a barrelful is fed in during the day's run. Just before running up the water level in the boilers at night, the balance of the solvent in the barrel is pumped into the boiler.

The object of this arrangement is to treat the water uniformly.

N. J. KEITH.

Dublin, Tex.

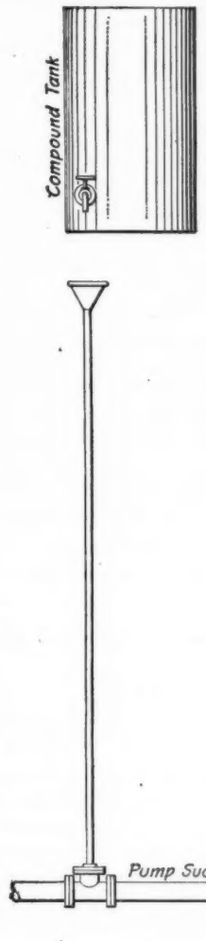
In reply to Frank H. Williams, in the January 3 issue, in regard to introducing boiler compounds, I submit the following arrangements both of which may be rigged up from material from the scrap pile.

The device shown in Fig. 1 did not prove to be very satisfactory because the solvent passed through the pump, caused it to stick and filled up the water chambers.

The arrangement shown in Fig. 2 was substituted and gave good results. The drain valve should be a gate valve. All the piping is of ⅜-inch material.

WILLIAM J. MARTIN.

Appleton, Wis.



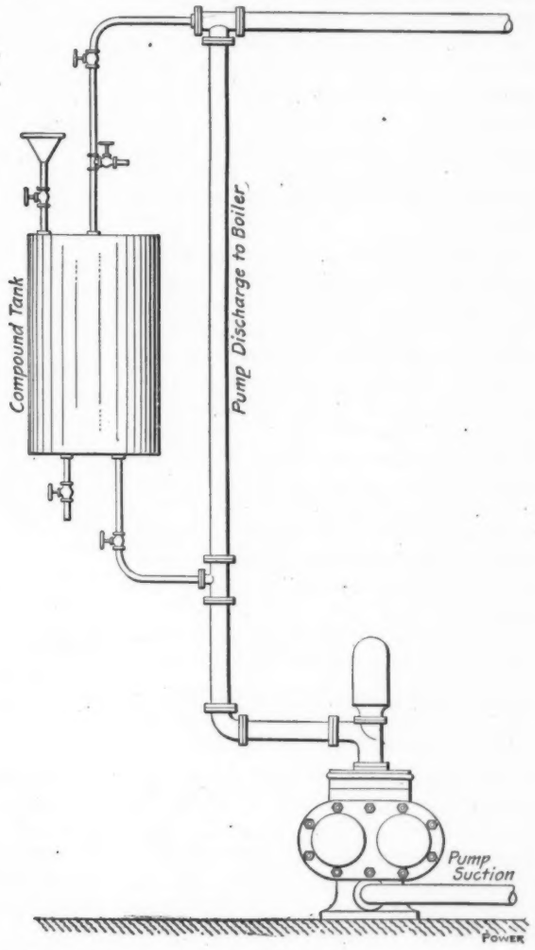


FIG. 1. TWO METHODS OF INTRODUCING SOLVENTS INTO BOILER FIG. 2.

An Engineer on Success

In the January 3 number, Mr. Eldredge writes about engine-room ethics.

No man can succeed unless he puts his whole soul into his work. With a determination to succeed he will surely rise to the top. It may take him years to do so but there is always a reward for those who keep steadfastly to their determination to win.

Many men make a mistake by not holding to one position, but moving around from one to another every few months.

The engineer who succeeds is the one who devotes his whole time and ability to the interests of his employer while on duty, and improves his spare moments by reading good engineering books or magazines.

We all have our ups and downs and the only way to come out on top is to keep up the spirit and determination to win.

GEORGE O. GRIFFITH.

Fort Flagler, Wash.

Does the Crosshead Stop

The above title has for many a weary week adorned the pages of POWER. The discussions upon the subject have been largely controversial; partaking of the nature of "Katy did" and "Katy didn't." Occasionally, there has been no reference to the subject and then I have put down my POWER thinking happily, "At last that crosshead has stopped." But no! next week it crops up again as lively as ever with elaborate diagrams to show that it stops—or doesn't.

So, in self defense, I humble myself to write upon the subject. And I do hope that mine will be the last word. So here goes:

If the crosshead does not stop, it must be moving. If it moves, it has a velocity. If it has a velocity, it must have a direction. If it has a direction, please let someone who votes that the crosshead does not stop say in *just what direction the crosshead is moving at the end of the stroke.* Let him put an arrow on a diagram to show in which direction it moves. If he can prove the direction, I will yield him the palm. But, if it is impossible to find a direction, clearly there is no motion, and no further argument is needed that the crosshead does stop.

JULIAN C. SMALLWOOD.

Syracuse, N. Y.

Engineer or Laborer

The advertisement copied in the editorial under the above title in POWER for January 31 is enough to make every engineer in the country sit up and take notice. There are cases where a young fellow who is trying to get experience could work for such pay and be excused, but for a man who is duly qualified to take such a position is shameful. I regret that the article does not state whether or not this position was in Massachusetts; it is no more attractive than some I have seen in the daily papers in this State. Engineers in other States, who are struggling for a license law, will tell us it has a tendency to raise wages. Come and see. Here are a few specimens:

In a large office building requiring continuous service, where the engineers work seven 8-hour shifts each, the engineer does his own firing, burns screenings, operates two boilers in summer and three in winter, keeps everything in good condition and tends to the engines, generators and switchboard, all for $14 per week. This job requires a second-class license.

A first-class engineer recently made vacant a position for which he was receiving $35 per week, and another engineer with a first-class license took it for $18.

Another engineer with a first-class license took a job for $16 per week while he was looking for something bigger to turn up. Before he had been there two weeks, another engineer came along and took his position for $14.

Well, who is to blame? Why, the engineers, of course. To do each other out of a job seems to be a malady that is fast growing among engineers.

The average operating engineer is the poorest paid mechanic in the country. Other mechanics are getting good pay and they cannot do each other out of a job, because they are organized, and in organization there is strength.

There is no mistaking the fact that the engineers of this country must organize. Not only engineers but every man engaged in the generation and transmission of power should be a member of one organization. Give us a national organization of all power workers, coupled with Federal license and inspection laws, and I will venture to say that within ten years we will have the wages of the average power worker increased wonderfully, and the engineer's profession raised to such a position as to command the respect of employers.

J. A. LEVY.

Greenfield, Mass.

Runaway Engines

It is surprising to note that hardly anything is being done toward reducing the number of flywheel explosions. Due to the results of such accidents not being so disastrous, perhaps, the general public and, indeed, those who are more intimately concerned with engines, are surprisingly complacent toward this type of accident. The lack of publicity as to the direct cause of flywheel explosions, due to the vigilant care of owners to baffle and prevent worthy investigation, is in a large measure responsible for fostering this indifference. A boiler explosion will occupy a very prominent space in the daily newspapers while often the reader must search minutely for mention of a flywheel explosion, and when he finds it, 99 times out of 100, the direct cause of the accident is not reported.

Why? Is it because the cause would incriminate the owner, or his servant, the engineer? That runaway engines are of frequent occurrence, though in the majority of cases stopped before damage is done, can be attested to by a large number of engineers.

When an engineer has once faced a runaway, by being obliged to stand in front of 12 tons or so of madly revolving iron, which at any moment may burst into a hundred pieces and hurl him to eternity, he generally afterward becomes most solicitous about all of the details which have to do with the safety of the flywheel. The chief cause of runaways is the governor belt, that often oil soaked, pieced, and badly spliced bit of hide to which one-half of engine builders are willing to commit the safety of valuable engines and their more or less valuable attendants.

My first experience was with a large central condenser pump with Corliss valve gear. Due to the breaking of the governor belt one afternoon it started to enliven matters by attempting to find out how fast it could go. As I descended the steps leading to the pit, I was met first by the crank-pin oil cup, and next by the oil pipe leading to it. The engine was stopped, however, without doing any further damage. My next experience was with an air pump, equipped with a throttling governor. To stop this runaway, also caused by the breaking of the governor belt, I was forced to stand on a step ladder and bend over one of the flying balance wheels to close the throttle. When stopped, the crank and wristpins were found to be smoking hot, and all of the foundation bolts loose. These two experiences inculcated the habit of extreme caution on my part, and taught me to seek answers to such questions as, what would I do if this, that or the other thing should happen. It is surprising how many things an engineer can do in an emergency—after full consideration under calm thought—and it will do no harm here to impress on young engineers the importance of considering the answers to these pertinent questions before an emergency arises, and not after the smoke clears.

A case to illustrate this happened some time ago. I was employed in a small textile mill erecting a line of shafting. It was my custom to spend my noon hour with the engineer, and during our conversations on engineering topics, I asked him what he would do if the engine ran away. The machine was a small slide-valve affair, equipped with a throttling governor that had no provision for stopping the engine in the event of the governor belt breaking, which, by the way, seemed to me from its condition to be imminent. His only resort at the time was to shut the stop valve on top of the boiler.

It was only a few days later that he was called upon to face the emergency. As I noticed the mill machinery speeding up, I called to the operatives to keep their looms running, and start up every loom that was idle, giving the example myself, for I had noticed that with a large percentage of the looms in opera-

tion, the speed often slackened, proving that the engine was hardly big enough to handle the mill load. But, much sooner than I expected, the racing looms slowed down. As I proceeded to the boiler room to congratulate the engineer on the remarkable agility he had shown in finding a ladder, climbing to the top of the boiler and closing the stop valve, I peeked into the engine room and beheld a most melodramatic tableau. Clinging to the lever of the 2-inch back-pressure valve that stood 10 feet above the floor and with one foot slowly but surely shutting the throttle was the engineer, while steam from several leaky gaskets was filling the place.

On being asked what had made him think of the back-pressure valve, he said that my inquiry as to what he would do when called upon to face this emergency had set him to thinking and had prompted him to try the expediency which had proved so efficacious.

Not long ago I had to deal with a very mysterious case of overspeeding on the part of a cross-compound Corliss engine, direct connected to a 1500-kilowatt alternator. I was about to stop this engine and, with a precaution that many would deem unnecessary, I had the oiler shut the throttle valve before pulling out the main switch. When this was done, we waited for the speed to slacken before releasing the steam and exhaust clutch on the high side. These clutches had been done away with on the low side as being unnecessary. To my astonishment and alarm, instead of slowing down, the engine began gradually but surely to increase its speed. Hastily I released the two clutches and, anticipating something wrong with the throttle, I picked up the starting bar and with it tightened the valve. Noting that the dashpot rods on the low side kept moving, I looked at the governor, but found it had assumed its highest plane, the spindle sleeve being tightly pressed against the top collar. Convinced that in some manner steam was being furnished to the low-pressure cylinder, I tried the low-pressure throttle, and while standing there I distinctly heard the hissing of steam, though the valve was closed tightly. Jumping over to the governor reach rod, I tapped it with the starting bar, bending it and thus shortening it, which brought the knock-off cams into action and prevented the valves from hooking. Then, as quickly as possible, the injection valve of the condenser was closed and the pump stopped. Upon investigating, I found that the low-pressure bypass valve was wide open. In order to pack the valve stem, the oiler had opened it to take advantage of the packing seat, and had forgotten to close it. It had no extension handle passing through the floor as the other valves had.

WILLIAM POWELL.

Ashland, Mass.

Pressure in Condensing Engine

The answer to a question in the January 17 issue under the caption, "Pressure in Condensing Engine," contains a statement that running an engine condensing is equivalent to increasing the pressure on the steam side of the piston to the extent of 10 or 12 pounds in average practice.

I think that the statement is misleading, as some would take it, that 10 or 12 pounds increase in initial pressure would give the same result, whereas it requires 10 or 12 pounds increase in the mean effective pressure.

F. M. BENNETT.

Chicago, Ill.

A Practical Compression Test

"Compression or no compression" is a subject that has frequently been discussed in and out of the technical journals for the past twenty years, to my knowledge. The matter is not yet settled, although I see by some of the articles and letters in POWER during the past year that some of the higher authorities in engineering are coming around to the side of no compression or, at least, very much reduced compression.

In the editorial "Two Diagrams" in the January 31 issue, the question is asked, "What is the real answer, and why does not some college laboratory find and announce it?" Must the answer come from "some college laboratory"? Can it not be found in steam plants where there is an opportunity to experiment and note results? It seems to me that it can, and to my knowledge it has been in one instance at least.

The plant, a street-railway power station, contained thirteen compound, condensing, Corliss engines of sizes varying from 500 to 1500 horsepower. The total horsepower was in the neighborhood of 8000 and for a few hours every day all of the units ran under full load. All of the engines had considerable compression in both high- and low-pressure cylinders, and were operated under a boiler pressure of 150 pounds and a receiver pressure of 15 pounds per square inch. During peak load both in the morning and the evening it was most difficult to keep up steam for even a half hour, and frequently the pressure would drop to 125 pounds, and sometimes even to 100 pounds.

After careful consideration it was decided to try reducing the compression in one of the engines, and at the same time increasing the receiver pressure. A few trials showed that the receiver pressure could be raised to 25 pounds, gage. The engine was run for a day under the changed conditions and seemed to do as well, if not better, than before, as far as ordinary observation was concerned. As, apparently, the engine suffered no unfavorable effect, it was thought that a similar change could be made in the operation of all of the other ones and it could then be very soon discovered whether gain or loss resulted.

One by one, the engines were gone over, until all were changed. As the work progressed it was noticed that it was less difficult to maintain the standard 150 pounds boiler pressure. When all of the engines were finished, the peak loads were carried day after day without any trouble in the boiler rooms at all. Now, as the load conditions had not changed, as no other changes were in progress at the time and as not only one day was taken, but a number of days, it certainly seems fair to assume that the improvement was due to the reduction in compression, the increase in receiver pressure, or to both. I think that each contributed its share of the decided improvement.

I am not going to attempt any theoretical explanation, nor do I care particularly about such, just at present, but I do know, positively, that after the changes less steam was consumed to do the same amount of work in the same period of time, and every one of the engines behaved splendidly while carrying its share of the load. There was no more dropping of steam pressure with the consequent long cutoffs and the disagreeable possibility of having to shift some of the load onto some of the other stations.

From a purely practical and commercial standpoint, what difference does it make as to just exactly what caused the improvement, as long as it was effected by the expenditure of a few hours' time on the part of the station men who were on duty anyway. There is hardly any doubt that had a mistake been made in reducing the compression and in increasing the receiver pressure in so many engines, it would have manifested itself immediately.

Set some of the boys to trying the thing out for themselves, and report the results to POWER. Report the exact conditions attending such tests, so that the whole truth may be known.

CHARLES J. MASON.

Scranton, Penn.

Belt Lacing

I was much interested in Mr. Keil's article on lacing belts in the January 10 issue. The illustrations were good, also the methods.

I wish some others would contribute articles on the same subject.

THOMAS CLARK.

Butte, Mont.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

One or Two Cylinders

We are now running an 18x36-inch engine which is supposed to develop 249 horsepower at one-third cutoff. The load has increased to 328 horsepower, and the engine takes steam seven-eighths of the stroke. If another side is put in the same as this, setting the crank pins on the quarter, would it take more steam to develop the same amount of power with the two engines than it does with this single one with the overload?

E. W. O.

A fair load for an 18-inch engine under average conditions of steam pressure is 175 horsepower. Two 18-inch cylinders will develop 328 horsepower on much less steam than one. The displacement up to cutoff will be about in the ratio of 8 for one cylinder and 5 for two.

Color of Ashes

What gives the fine ashes in the combustion chamber of an ordinary return-tubular boiler their reddish color?

C. O. A.

The color is due to the presence of sesquioxide of iron.

Peak Load

What is meant by "peak load"?

E. E. P.

The term refers to the heaviest load of the run. Where the load curve is plotted on a chart, the highest point reached is called the peak.

Brake Horsepower

What is the brake horsepower of an engine?

E. P. E.

Brake horsepower is the term applied to the power delivered from the flywheel or engine shaft. It is that determined by brake measurement, hence the term. It is the net horsepower as distinguished from the indicated horsepower, which is the power developed in the cylinder.

Effect of Safety Valve Opening

If the quick opening of a valve or the breaking of a pipe or fitting reduces the pressure in a boiler and causes a water hammer, why is there not a water hammer every time the safety valve blows?

E. S. O.

When a safety valve blows there is no sudden reduction of the pressure in the boiler. The opening of the valve prevents any further rise and if there is any appreciable reduction due to excessive "blow back," this reduction is accomplished slowly instead of rapidly as is the case with a broken pipe.

Compound Engine Cranks

In a cross-compound engine which will give the better results, to have the crank pins 90 or 180 degrees apart?

C. E. C.

It will make no difference in steam economy. But there will be a more uniform turning effect on the shaft with the cranks at 90 degrees.

Granulated Babbitt Metal

How can I make a granulated babbitt metal?

G. B. M.

Melt the metal in a ladle, remove the ladle from the fire and allow the metal to cool. When it begins to "set," stir briskly with a stick until it has all cooled into a granular mass. If any particular size of grain is desired, the metal may be sifted, using two screens, one of the desired size mesh to remove the large grains and one slightly smaller to allow the escape of the fine or too small grains.

Disabled Valve Gear

If the connection on one of the exhaust valves of the high-pressure cylinder of a triple-expansion Corliss engine should get broken, what should be done in order to keep on running?

O. W. L.

Block the exhaust valve open, then shorten the dashpot rod of the corresponding steam valve until the hook will not engage. This will leave the steam port closed and the high-pressure cylinder will run single acting.

Cutting Boiler in with Others

How should a boiler, in which steam has been raised, be cut in with others?

C. B. O.

As the steam pressure approaches that in the others, the draft should be checked and the pressure allowed to increase slowly until it is within a pound or two of the other pressure, when the connecting valve should be slowly opened.

Area of Steam Port

How is the size of the steam ports of an engine cylinder found?

A. S. P.

The velocity of the steam entering the cylinder should not exceed 100 feet per second. To find the area of a steam port for this velocity, multiply the piston area in square inches by its travel in feet per second. This product divided by 100 will give the required area of the port in square inches. Dividing the area of the port by its length will give the width.

Tubes, Flues and Pipes

What is the difference between tubes, flues and pipes?

T. F. P.

It is in the terms of the diameter. Tubes and flues are measured by the external diameter. Boiler-tube sizes run to 4½ inches. Above this they are called flues. Iron and steel pipe is measured by the internal diameter up to 12 inches and by the outside above this. Cast-iron pipe of all diameters is measured on the inside.

Corrosion and Remedy

What is corrosion in a boiler and how can it be prevented?

C. A. R.

It is the gradual rusting or dissolving of the metal by the water or oxygen or acid present in it. It may be prevented by analyzing the water and introducing such elements as will neutralize the corroding agents.

Total Pressure in Boiler

What is the aggregate pressure tending to burst a boiler 6x18 feet, carrying 120 pounds pressure per square inch?

T. P. B.

The total pressure on the shell is

$$3 \times 3.14 \times 18 \times 144 \times 120 =$$

2,879,996.8 *pounds.*

The pressure on the heads if supported by the tubes and stays has no bursting tendency.

Comparative Value of Wood and Coal

How does wood compare with coal in fuel value?

C. V. C.

Dry wood has a heat value per pound of about 0.4 that of carbon. There is little difference in the fuel value of the different kinds of wood, pound for pound.

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POWER

The Coal Mine Operator's Profit

In the January 17 issue of POWER an editorial entitled "The Consumer Pays the Bill" was published. Our contemporary, *The Black Diamond,* took exception to some of the statements made, and tried to tell the coal operators that they are not receiving enough money for the smaller sizes of anthracite coal.

According to *The Black Diamond's* own statement, sixty-two per cent. of the anthracite coal now mined is sold for domestic use, and the remaining thirty-eight per cent., which is broken up into the small sizes, is sold for steaming purposes, so that there is practically no waste of actual combustible. Not long ago these smaller sizes were thrown away and therefore represented no income. During the year 1909 there were 855,933 tons of No. 1 buckwheat, 1,336,466 tons of No. 2 buckwheat and rice and 1,172,831 tons of No. 3 buckwheat coal taken from the washeries as against 8,287,460 tons of No. 1 buckwheat, 4,283,417 tons of No. 2 and rice and 2,145,938 of No. 3 buckwheat coal taken from the mines.

Coal is being mined almost as cheaply today as it was ten or fifteen years ago, but the selling price to the consumer is higher than it has ever been, under ordinary conditions; yet *The Black Diamond* contends that the money received from the sale of the smallest sizes is not "velvet" and asserts that inasmuch as it costs just as much to mine the fine coal as it does to mine the larger sizes, the anthracite companies should charge more for the small sizes instead of less. This argument might have some merit if the prices of larger sizes had been reduced when the operators began selling the fine sizes.

If the income from sixty-two per cent. of the coal mined formerly paid a good profit over the cost of mining all of it, how much profit must there be now that all of it is sold without any reduction in the price of the larger sizes? The average price of the larger sizes at the mine last year was about two dollars and ninety-two cents per ton, and less than this formerly paid a profit on the cost of mining a little over one and one-half tons of combined large and small sizes. The average price of small sizes is one dollar and twenty-five cents per ton, or fifty cents on each ton of available fuel mined. Result: instead of receiving one dollar and seventy-five cents per ton of available fuel mined, the operators receive two dollars and twenty-five cents per ton, although the cost of mining has not increased as much as the selling price of coal since the small sizes were "dumped." If that is not fifty cents of "velvet" per ton of fuel, what is it? And who pays it, if not the consumer?

Boiler Inspection and Engineers' License Legislation

It is interesting to note that the persistent agitation on the part of the more intelligent engineers for the enactment of boiler-inspection and engineers' license laws is beginning to be felt where no laws of this nature exist. There are before the legislatures of the States of New York and Kansas concise and comprehensive propositions for the examination of engineers. And there has just passed both houses of Congress a bill providing for the annual inspection of locomotive boilers.

These are steps in the right direction and when all of the States have enacted suitable inspection and license laws a part of the coronor's occupation will have disappeared. Uniform license laws throughout the country, honestly administered, will eliminate the incompetent engineer and one form of menace to life and property will disappear.

Consistent boiler-inspection requirements forbidding the installation and use of boilers of defective construction and compelling the rigid examination of all already installed will add to the length of the undertaker's vacation. The most rigid laws and the utmost vigilance in their execution will probably not entirely prevent boiler accidents, but such action will reduce them to the lowest possible number. Periodic inspections have prevented almost numberless explosions, and hundreds of others would have been prevented by the existence of common-sense laws. There are no boiler laws in New Hampshire. In 1908 on a boiler belonging to the town of Dartmouth, Mass., the pressure allowance was reduced by a State inspector to a point which rendered it useless to the municipality as a source of steam supply and it was sold for junk for fifty dollars to an alleged engineer who represented to the New Bed-

ford Ice Company that the boiler was safe for a much higher pressure than that allowed by the State inspector. The boiler was taken to New Hampshire and installed for use during the ice harvest. It exploded on the first day of its use, killing the man who said it was safe.

Last summer at Laconia, a boiler in the Lakeport steam laundry exploded with fatal results. Had laws similar to those of Massachusetts been in force in New Hampshire, neither of these boilers would have failed, and the State would not be characterized as the dumping ground for worn-out Massachusetts boilers.

Sign Your Full Name

From Detroit, Mich., there comes a question about the method used to determine the efficiency of riveted seams. The question is a reasonable one and is intelligently stated. But after the question comes this plea: "Now, do not turn this down and say that you have shown this more than a hundred times during the last twenty years, but kindly and considerately remember that there are many young men just beginning to read POWER while the older readers are passing away. Editors sometimes forget that new men are coming up as the old ones go, by the thousand, and refuse to reply to a question a second time. Please do not treat this one that way."

Four times within two years this question has been answered in the columns of the paper and more than fifty times by personal letter, just as it would have been in the present instance if the writer had signed his name to the letter he so painstakingly wrote.

Sometimes a correspondent will sign a letter with his initials only and hundreds of letters have been answered where the only clues to the addresses were the post mark on the envelop and the initials which fitted a name on the subscription list.

Hundreds of letters are received, read, answered and filed at this office every working day of the year and it is not strange that a few mistakes occur. But it is strange that the most, in fact nearly all, of the unsigned letters received at this office are written by engineers. Anonymous letters are annoying, whether the omission of the signature is intentional or otherwise; but are doubly so when concealment makes it impossible to perform a service so manifestly expected, as in the instance mentioned.

Engineers are not as a rule careless; their work and training, and the responsibilities of the positions they occupy preclude this. But some do slip, and when they do, how often will they accept the suggestion that possibly or very probably the miscarriage of a project was due to negligence on their part?

This was not written wholly for the subscriber in Detroit, whose question will, in the near future, be answered in the reading columns, but for all who feel that they have not been given courteous attention. This journal is for its readers, and the whole office force from the office boy to the president is at their service and they have only to ask to receive and that quickly, if they ask aright by plainly signed letters.

Stress in Boiler Sheets

It is a well understood fact that in a cylinder under pressure the stress upon the metal per unit of section is twice as much when the section is taken parallel with the axis as when it is taken at right angles thereto; that in a cylindrical boiler, for example, this stress is twice as great upon the longitudinal as upon the roundabout joint.

This stress upon the longitudinal section has been considered by designers as the maximum stress per unit of section to which the sheet is subjected by reason of the pressure; but on page 1935 of POWER for November 1, 1910, Mr. Adler advances the idea that these two stresses acting at right angles have a component acting diagonally through the sheet greater than either of them.

This proposition seems open to argument, and we should like to have expressions of the ideas of our readers concerning it.

Suppose a sheet of boiler steel to be stressed lengthwise, as in a testing machine, up to its breaking point. Would it break under any less stress and would the direction of the line of fracture be any different if at the same time it were subjected to a crosswise stress one-half of that which was being applied lengthwise?

If a square piece of perfectly homogeneous boiler steel were submitted to tensile stresses, uniformly applied to all four sides and normal to those sides, would it break into four squares or four triangles, that is, would it break on the diameters or on the diagonals?

High Boiler Efficiency

Some time ago we published the report of a test upon the boilers of the Government plant at Panama, showing an efficieny of over eighty-two per cent. Under the terms of the contract a bonus of over seventeen thousand dollars was earned by the builders upon the strength of this test. The report was furnished us by the makers of the boilers and was signed by the testing engineer for the Government.

Since publishing the report, we have received several communications questioning the correctness of the figures, and upon taking the matter up with the makers, they admit that they are at a loss to account for some of the figures. Computed rationally, the efficiency should have been about seventy-five per cent.

Hanging On to Water Power

Another instance of the keeping of the hands of the people upon their power supply is the refusal of the House of Representatives to cede perpetual control of the water power of the St. Lawrence river to the Aluminum Company of America. The Government should either itself develop or encourage the development of water powers as fast as there is a demand for them, but under such circumstances that the people can retain their rights therein and be guarded against excessive charges.

Louisville, Ky., is also out for an international exposition in 1915. The excuse is that that year marks the fiftieth anniversary of the end of the Civil war. It is to be known as the Lincoln-Davis exposition and held at Louisville as both Abraham Lincoln and Jefferson Davis were natives of Kentucky. The real 1915 exposition will be held in San Francisco and will commemorate the completion of the Panama canal. We are big enough, however, to run two international expositions at once, if it has to be done.

Have you had or do you know of any trouble with boiler tubes recently? If so, what kind of a tube was it; iron or steel, lap or butt welded or seamless, standard thickness or under or over gage? How did it fail; in the seam or elsewhere, by thinning down or breaking a piece squarely out? What were the conditions of the tube as to cleanliness, and how much water was it evaporating per square foot of heating surface?

Camille Flammarion, who in a recent issue of the *New York American* takes a Look One Thousand Years Ahead, says that "Electricity will, of course, have taken the place of steam." Where are they going to get the electricity? At present, "juice" is not a substitute for but a product of steam power.

Pittsburg will entertain the Mechanical Engineers in May. This will be the second time in the history of the society that it has met at Pittsburg, the first being in 1884.

When are they going to try John Carroll? They are waiting for him in Philadelphia after the Boston authorities get through with him.

It is rumored that the committee on power tests of the American Society of Mechanical Engineers has turned over in its sleep.

The crosshead does stop at the end of the stroke.—*Punktum.*

Prevention of Industrial Accidents

An analysis of the principal causes of injury in industrial establishments and recommendations as to the preventative measures to be adopted.

At a recent meeting of the American Society of Mechanical Engineers, John Calder presented a paper upon "The Mechanical Engineer and the Prevention of Accidents," which was, in part, as follows:

Accident clauses have been included in the labor laws of the various States for some years, but the provision for administering these laws effectively has always been inadequate.

In study and legislation upon the subject, this country is far behind Great Britain, Germany and France, which countries more than thirty years ago began to enforce the existing laws with strictness and excellent technical judgment. The reports of the Bureau of Labor show that the yearly mortality from industrial accidents, among adult wage earners alone, in the United States is between 30,000 and 35,000. It is estimated that the nonfatal injuries reach nearly 2,000,000 annually.

Scientific study and a solution by the mechanical engineer of individual problems of safeguarding, supervision and instruction of employees, as they arise in daily routine work, will do more than all other existing agencies to bring about satisfactory results. In such matters the attitude and action of the executive are all important. However, all industrial accidents are not to be considered preventable, either by employer or employee. Furthermore, of those that may be avoided, some do not fall strictly within the province of the engineer, but are directly within the control of the injured themselves.

An analysis of many thousand industrial accidents shows them to have been due principally to the following causes: ignorance, carelessness, unsuitable clothing, insufficient light, dirty and obstructed work places, defects in machinery and absence of safeguards. Accidents due to the culpable, as well as excusable, ignorance of supervisors, engineers, millwrights, elevatormen, etc., may be reduced only by administrative vigilance in selecting and instructing these employees. As for carelessness, the average American workman is very apt to take foolish and unnecessary chances with life and limb and the only way to guard against this is by the maintenance of strict discipline in the shops, the adoption of salutary punitive measures and the elimination of the dangerous employee, in addition to an educational campaign throughout the plant.

Much eloquence has been expended from time to time on assumed inherent and deadly defects in machinery and structures used in the arts. These, while contributing to some serious and a number of minor casualties, do not approach the extent commonly alleged. It certainly does not pay any employer to keep a defective machine in operation; nor is it in the interest of the employee to use imperfect apparatus which reduces the possible earnings. On the other hand, it is by no means infrequent to find workmen who have their choice of the best material and apparatus and who possess the intelligence to apply these correctly, showing a striking disregard for their own safety; this is especially true in temporary structures, such as scaffolds, frayed ropes, etc.

The absence of safeguards, although not the most prolific cause of accidents in plants, as is commonly supposed, nevertheless closely concerns the mechanical engineer who holds the possibilities largely in his own hands. However, in many cases of injuries caused by the absence of safeguards, it has been found that these were removed or rendered ineffective by the operatives themselves. All safeguards should be so designed as not to interfere with the speed and ease of operating the machine.

Mr. Calder illustrated a number of safeguarding devices, applicable for the most part to industrial machines. Regarding power-house appliances he recommended that the edges of all stairs, platforms and gratings should have low fenders on both sides to prevent nuts, bolts, tools and other small parts rolling off onto the machinery or striking employees. Also, a double metal railing not less than three feet high and not nearer to any moving part than twelve inches should be provided at all dangerous places, such as crank and flywheel pits and the edges of all stairways. Metal tubing and disk guards should be used for all shafting, bearings and pulleys requiring to be approached closely while in motion. Seven feet clear of every moving part is considered the least hight from the floor level without guarding and, even then, where a horizontal belt drives across a frequented passage it is well to have the lower side screened to avoid injuries caused by "whipping" if the belt should break.

Discussion

The discussion of the paper was opened by Professor Hutton, president of the American Museum of Safety Devices, who showed lantern slides of numerous devices and commented upon their effectiveness. A number of the devices shown were of German design and, although practically a sure preventative against accidents, many of these were of such design as to impede the speed of the operator or make their cost prohibitive. Professor Hutton laid particular stress upon the subject of signs, pointing out that the majority of signs were ineffective for two reasons: First, owing to the number of foreigners employed in this country, it is essential that the signs be printed in several languages; second, they are usually of a cautionary nature and are not expressed forcibly enough. In this connection, he called attention to the practice of the United States Steel Corporation which uses the symbol of a skull and crossbones to denote a death danger.

The next speaker, Mr. Cummings, dwelt to some extent upon the economic side of the question, showing that outside of humanitarian considerations it actually paid the manufacturer to install safety appliances. It was shown that nearly all the courts hold that if an accident occurs from any device or machine, it is not valid evidence that it is not customary to guard that machine, but is accepted as *prima facie* evidence that the machine being dangerous, the accident should not have happened and the machine could have been guarded. Thirty-one cases were cited, happening within thirty days in the State of Minnesota, in which judgment of over $140,000 were awarded by the courts; of this only $6000 was deducted by reversed decisions.

Mr. Cummings also referred to the preventative methods adopted by the United States Steel Corporation which have reduced the number of accidents 50 per cent. Here, besides the mechanical appliances employed, much of the credit is due to the system of inspection, which makes every foreman and workman an inspector. A set of inspectors is appointed in each department for a certain period, at the end of which these men go back to their work and others take their place, and so on. However, the fact of their going back to work does not relieve them of responsibility of inspection, as they are supposed to keep continually upon the alert for defects. In this way all the men are trained.

J. W. Alexander, while conceding that machines should be made safe, believed that it was not necessary to make them foolproof. He thought that more attention should be given to working conditions, the coöperation of the workmen, clothing, etc., and suggested that a committee of engineers be appointed to collect the available data on safety appliances and standardize their use.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

Diamond Tube Blower

A new soot blower, known as the Diamond, has been designed for use with water-tube boilers, and is illustrated herewith. By its use soot can be cleaned from the tubes without waiting for the boiler to cool down, and as often as the operator may desire.

Fig. 1 gives a good idea of the construction and mechanical parts of the device. Fig. 2 shows three blowers installed on one boiler having two vertical baffles, and under such circumstances

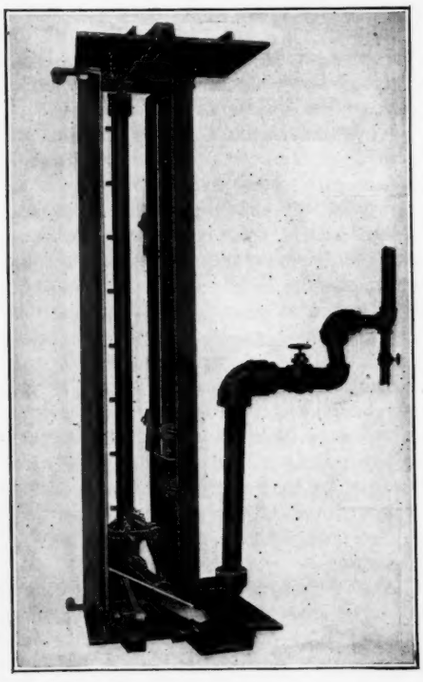


FIG. 1. DETAILS OF BLOWER

three blowers are required, one each side of the baffles. If the boiler had only one baffle, but two blowers would be necessary.

This blower is also applicable to boilers having horizontal baffles, in which case the number of blowers required is regulated by the length of the boiler, but any ordinary length can usually be covered by two blowers.

The blower is intended for use on boilers in which tubes are laid in even horizontal or nearly horizontal rows, when there is a clear passage between each row of tubes from one side of the boiler to the other, so that a jet of steam may pass through this space unobstructed for the full width of the boiler.

This blower is very simple in design, having no complicated parts to be destroyed by the effect of heat, soot or dirt.

There are three main parts to the blower: the door frame, the door and the standpipe resting on its slide. The slide operates in a groove in the top and bottom plates of the frame, and is moved in and out of the operating position by means of a vertical hand lever, as shown in Fig. 1, this lever being in a vertical position when the device is out of use, and in a horizontal position when the blower is thrown into the operating position.

When the blower is not in use it is protected by the door which closes behind the standpipe. This protects the working parts of the blower from the heat of the boiler, no parts being exposed when the blower is not in use. The door itself is protected by a filling of asbestos and cement about ½ inch thick.

When the blower is thrown into an operating position, by pressing down the lever, the standpipe is moved toward the inner side of the boiler wall so that it projects slightly beyond the inner face of the boiler setting.

In cleaning the tubes the standpipe is rotated through an arc of 180 degrees, or 90 degrees to the right and 90 degrees to the left, by the geared handle on the pinion shaft, as shown in Fig. 1.

The standpipe is provided with small jets so placed that one will come between each row of boiler tubes, and as the operator turns the handle, a jet of steam is thrown between each row of tubes from one side of the boiler to the other, and within the limits intended to be covered by one machine.

This blower is manufactured by the "Diamond" Power Specialty Company, 80-82 First street, Detroit, Mich.

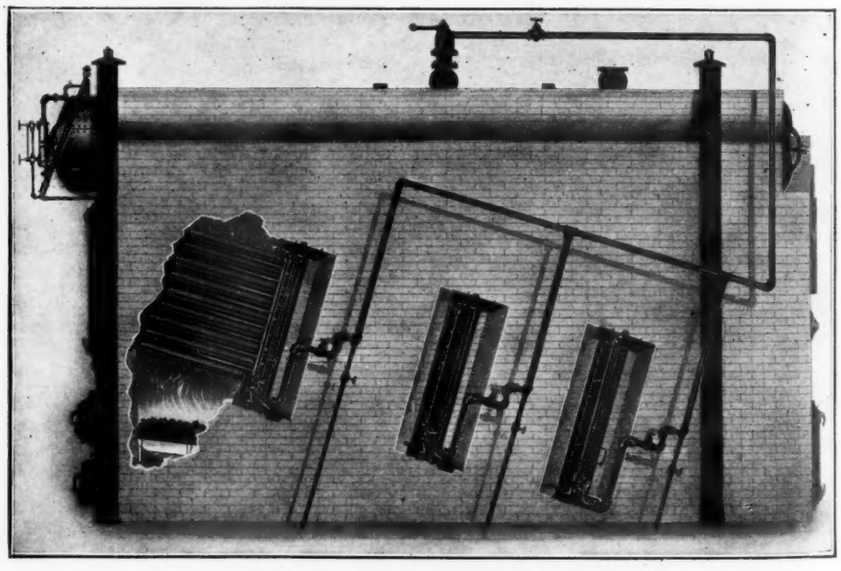
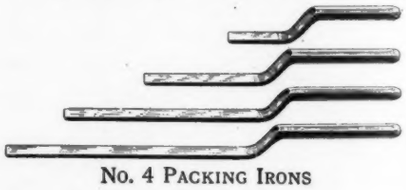


FIG. 2. APPLICATION OF BLOWER TO A BOILER

Mound No. 4 Packing Irons

These tools are for the purpose of replacing packing in the stuffing box of an engine, pump, etc.

They are forged from tool steel, and, having no sharp edges, are not liable to cut the piston rod during the process of packing.



NO. 4 PACKING IRONS

There are four tools in each set, each 7, 9, 11 and 14 inches long, and they are nickel plated. The set is known as No. 4, and is made by the Mound Tool and Scraper Company, 7 Hickory street, St. Louis, Mo.

Court Rulings on Pittsfield Explosion

By John L. Robbins

In filing the report of the inquest on the recent boiler explosion at Pittsfield, by which seventeen lives were lost, the court found that there was violation of law in substituting a new safety valve of larger size and increased pressure for the one allowed by the State inspector, and in afterward tampering with the safety valve and thereby greatly increasing the pressure at which it was set. But it was held that no one living was responsible for it.

With a view to preventing further accidents from a like cause, it was recommended that the law be so amended as to require that all connections between the steam gage and the boiler shall be of brass or other metal that does not rust, and that all safety valves on boilers which require a licensed engineer to run them, shall be locked and a key kept in possession only of the State inspector of that district in which the boiler is located.

Long Beach Plant of the Southern California Edison Company

To insure continuity of service, the Southern California Edison Company has already invested about $2,000,000 in steam auxiliary generating plants to supplement in case of necessity their hydroelectric developments on the Kern river, the Santa Ana cañon and other water courses that derive their flow from the Sierras.

At Long Beach a steam plant is now under construction which will have a total ultimate capacity of 125,000 horsepower when entirely completed. This amount of energy will be necessary for carrying the peak loads of Los Angeles and the towns of southern California. The final cost of this plant will be about $6,000,000.

The new station, which will be located on a site adjacent to the inner harbor, will comprise two buildings having a combined floor space of nearly an acre. The generator and boiler house will have a floor area of 30,000 square feet and will be 60 feet high, while the transformer building will cover 7500 square feet and will be four stories in hight. Both structures are to be of reinforced concrete with artificial-stone base, ornamental cornice and mission-tile roof. The generator room will have a floor of imported Welsh quarry tile, with a glazed-tile wainscot. Everything considered, this will be the most handsome and best equipped steam plant west of Chicago.

The main unit will consist of a steam turbine of 12,000 kilowatts capacity. For supplying steam to this turbine, there will be eight 750-horsepower Stirling boilers. Crude oil will be used for fuel, large concrete supply tanks being located on the west end of the property. This oil will be shipped in tank cars or may be pumped through a main which now runs by the company's property. Salt water will be used for condensing purposes.

Although only one unit will be installed at the present time, the buildings are being built of ample size for two large machines with their boilers and auxiliaries. The property on which the plant is located will allow for future growth. Frederick Sargent, of Chicago, has been retained as consulting mechanical engineer. The Edison company's engineering department is supervising the construction work and has made all of the designs and plans, except the purely architectural details which were designed by Parkinson & Bergstrom who have been retained as consulting architects.

Cost of Industrial Power

On Friday evening, March 10, the American Society of Mechanical Engineers, coöperating with the American Institute of Electrical Engineers, will hold a meeting on the cost of industrial power in the Engineering Societies, building, 29 West Thirty-ninth street, New York. Papers will be presented on power costs by members of both societies. All members having intimate knowledge of cost of producing power in either central or isolated and industrial plants are invited to take part in the discussion. That there may be a proper standard for comparison it is necessary that the cost figures be itemized and the method of analysis by which each is determined, together with primary data from which determined, be given in detail. It is hoped that reliable information as to practical year in and year out operating costs will be presented so that it will be possible to differentiate between test conditions and actual operating costs. Those intending to discuss the question are requested to notify the New York meetings committee at an early date.

The Naval Dinner

On February 11, the American Society of Naval Engineers held its third annual banquet at Rauscher's, Washington, D. C. The banquet was a brilliant one and well attended by representative men of the naval, executive and army departments. Walter M. McFarland was toastmaster. Ernest W. Roberts, L. P. Padgett, Rear Admiral R. Wainwright and Col. Robert M. Thompson were on the program for toasts to the navy and Rear Admiral Melville concluded the speaking with a few brief remarks on the navy of the past and the present.

Newport Cannot Use Rhode Island Coal

Rhode Island coal may burn satisfactorily in some cases, but reports from Newport indicate that it cannot favorably compete with other coals for boiler use. Bids for supplying the city hall and overseers of the poor with fuel for the present year were requested by the board of aldermen. Rhode Island coal was offered at the lowest price and the company's agent in Newport was given a chance to take charge of the city-hall furnaces for a few days. The engineer of the plant reported that while the coal seemed to burn well enough, its heat value was apparently low and with the equipment in the plant did not raise steam as readily as other coals. An unsatisfactory report was also received from the overseers of the poor.

Oil Burning Engines for New Haven Road

It is reported in the daily press that the New Haven road is planning to try oil-burning locomotives on a more extensive scale than has been attempted by any other railroad in the East.

One locomotive has been transformed and the directors of the road will consider at their next meeting the project of converting twenty-two more locomotives.

The road has been quietly running an oil-burning locomotive daily from Boston to Provincetown, Cape Cod. The experiments show a saving of $12 a day and a speed fully as great as that of coal-burning engines.

Boiler Explosion in Philadelphia

On February 15 a boiler exploded in the basement of the candy factory of H. Nuss & Co., Philadelphia. The engineer of the plant was killed and considerable damage to the boiler room is reported.

Locomotive Explodes

A locomotive-boiler explosion is reported in the daily press to have occurred in Smithville, Tex., on February 9. Ten were killed and nine injured and a property damage of $20,000 was effected. Details of the explosion will be given in an early issue.

PERSONAL

Frank Koester, previously with the Interborough Rapid Transit Construction Company, J. G. White & Co., the Guggenheim Exploration Company and the American Smelting and Refining Company, all of New York, recently opened an office at 115 Broadway, New York City, as consulting engineer. Mr. Koester

is author of "Steam Electric Power Plants" and "Hydroelectric Developments and Engineering."

Arthur Ritter has succeeded Clayton W. Old as manager in charge of the New York sales office of the American Blower Company. Mr. Ritter has been connected with this company for a number of years and is well and favorably known among its clientele in the New York section.

SOCIETY NOTES

The next meeting of the Engineering Society of Wisconsin will be held in Madison on March 8, 9 and 10.

The spring meeting of the American Society of Mechanical Engineers will be held in Pittsburg, Penn., May 30 to June 2.

The national convention of the Building Owners and Managers Association will be held at Cleveland, O., on July 10, 11 and 12.

The Southern Supply and Machinery Dealers' Association, the National Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association will hold a triple joint convention in Louisville, Ky., on April 3, 4 and 5, 1911.

On the evening of March 9, 1911, the Institute of Operating Engineers will hold its second monthly meeting in its rooms in the Engineering Societies building, 29 West Thirty-ninth street, New York. William D. Ennis, professor of mechanical engineering in the Polytechnic Institute of Brooklyn, will deliver a paper on "Commercial Aspects of the Work of the Operating Engineer." Two other prominent engineers will be called upon to enter into the discussion of the paper. As this subject is one of great importance to the operating engineer, a large attendance is expected.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

INTERNAL COMBUSTION ENGINE. William J. Perkins, Grand Rapids, Mich. 983,307.

COMBUSTION ENGINE. Jakob Sulzer, Winterthur, Switzerland. 983,322.

INTERNAL COMBUSTION ENGINE. Leonard Archibald Vallillee, Buckingham, Quebec, Canada. 983,328.

TWO-CYCLE GASOLENE ENGINE. Fred Howes, Burlington, Vt. 983,369.

INTERNAL COMBUSTION ENGINE. Thos. Turnbull, Jr., Pittsburg, Penn. 983,583.

TURBINE. Byron Stevens, Oakland, Cal. 983,653.

ROTARY ENGINE. Franklin Priestley Nichols, Houston, Tex. 983,754.

BOILERS, FURNACES AND GAS PRODUCERS

STEAM GENERATOR. John N. Leach, Melrose, Mass., assignor, by mesne assignments, to Judson L. Thomson Manufacturing Company, Waltham, Mass., a Corporation of Maine. 983,296.

MECHANICAL STOKER. Edgar D. Newkirk, Canastota, N. Y., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania. 983,305.

WATER-TUBE BOILER. Amasa Worthington, New York, N. Y. 983,339.

OIL BURNER. William S. Dowell, El Reno, Okla. 983,484.

SMOKE CONSUMER. Charles D. Leonard, Rochester, N. Y. 983,503.

SMOKE-CONSUMING FURNACE. John W. McNeal, Chicago, Ill. 983,510.

GRATE. Robert Hilprecht, Lansing, Mich. 983,716.

POWER PLANT AUXILIARIES AND APPLIANCES

FEED-WATER HEATER. Francis Hodgkinson, Edgewood Park, Penn., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania. 983,282.

STARTING DEVICE FOR EXPLOSIVE ENGINES. Frederic N. Howard, Harris, R. I. 983,282.

OIL SAVER. Clark F. Rigby, Butler, Penn. 983,314.

FEED-WATER CONTROLLER. George Fleming, Chicago, Ill. 983,356.

PUMP. Byron W. Haskell, Oakland, Cal. 963,365.

STEAM TRAP. Jarad W. Lytton, Franklin, Va., assignor to Lytton Manufacturing Corporation, Franklin, Va., a Corporation of Virginia. 983,384.

LINING FOR ENGINE CYLINDERS. Einar N. Sorensen, Athens, Penn. 983,409.

CARBURETER. William T. Dawson, Helena, Ark. 983,541.

ROTARY GAS-ENGINE VALVE. William E. Ewart, Seattle, Wash. 983,546.

VALVE GEAR FOR ENGINES. Charles D. Parker, Worcester, Mass. 983,564.

COMPRESSOR. Henry W. N. Cole, Brooklyn, N. Y. 983,605.

COAL-HANDLING APPARATUS. George E. Titcomb, Philadelphia, Penn., assignor to the J. M. Dodge Company, Naugatuck, Conn., a Corporation of Pennsylvania. 983,659.

HOSE COUPLING. John E. W. Boesch, Columbia, Nev. 983,671.

LOCK COCK. Joseph Schneible, Weehawken, N. J., assignor to Schneible Company, Buffalo, N. Y., a Corporation of New Jersey. 983,842.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTRIC HEATER. Milton M. Kohn, New York, N. Y. 983,291.

ELECTRIC FURNACE. Hans Nathusius, Friedenshütte, near Morgenroth, Germany. 983,303.

ELECTRICAL SIGNALING DEVICE. Jey Glenn Schafer, Brighton, Iowa. 983,403.

MOTOR-CONTROL SYSTEM. Emmett W. Stull, Milwaukee, Wis., assignor to Allis-Chalmers Company, Milwaukee, Wis., a Corporation of New Jersey. 983,519.

ELECTRIC SWITCH. Charles S. Van Nuis, Philadelphia, Penn. 983,680.

ALTERNATING-CURRENT SYSTEM OF DISTRIBUTION, REGULATION AND CONTROL. Joseph Bijur, New York, N. Y., assignor, by mesne assignments, to the Electric Storage Battery Company, Philadelphia, Penn., a Corporation of New Jersey. 983,670.

ELECTRICAL WRITING APPARATUS. Dinshah Pestanji Framji Ghadiall, Surat, India. 983,703.

INSULATOR FOR ELECTRIC INSTALLATION CANOPIES. George W. Gardiner, Chicago, Ill. 983,701.

POWER PLANT TOOLS

PIPE WRENCH. Frank F. Corbin, Easthampton, Mass. 983,267.

PIPE WRENCH. Ernst Enderes, Littleport, Iowa. 983,271.

WRENCH. William N. Jay, Moscow, Idaho. 983,447.

WRENCH. Andrew J. Curtis, East Williamson, N. Y., assignor of one-half to Daniel Wagemaker, East Williamson, N. Y. 983,483.

PIPE-FLANGE WRENCH. Michael Murray, Chicago, Ill. 983,562.

WRENCH. Robert D. Lindsay, Monaca, Penn. 983,628.

WRENCH. Edward Kukuruda, Saginaw, Mich. 983,728.

WRENCH. Elnathan Allen, Chicago, Ill. 983,796.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Col. E. D. Meier; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting in Pittsburg, May 30 to June 2.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff; sec., T. C. Martin, 31 West Thirty-ninth St., New York. Next meeting in New York City, May 29 to June 3.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Commander U. T. Holmes, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next meeting to be held September, 1911, in Boston, Mass.

WESTERN SOCIETY OF ENGINEERS

Pres., O. P. Chamberlain; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., Walter Riddle; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Pres., R. P. Bolton; sec., W. W. Macon, 29 West Thirty-ninth street, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting at Detroit, Mich., January, 1912.

INTERNAL COMBUSTION ENGINEERS' ASSOCIATION.

Pres., Arthur J. Frith; sec., Charles Kratsch, 416 W. Indiana St., Chicago. Meetings the second Friday in each month at Fraternity Halls, Chicago.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; acting sec., Charles P. Crowe, Ohio State University, Columbus, Ohio. Next meeting, Youngstown, Ohio, May 18 and 19, 1911.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

"Have then thy wish, and wisdom finds the way."

An ex-lieutenant governor was addressing a New York High School Alumni at an annual banquet.

For his subject he chose ambition and how necessary it is for a man to have an aim if he wishes to succeed.

Feeling his way at first, he soon became enthusiastic and cited case after case where successful men had started out wishing for a certain high place and then worked their way up until they reached it.

He showed where some had achieved their aim early, others later, but he proved that the men who were constantly working toward success, were always found ready when opportunity came along.

Proving that when a man wished for a certain thing and then concentrated all his efforts on getting it, wisdom somehow or other found the way of securing it.

"Have then thy wish, and wisdom finds the way," were the words he wound up with.

His talk was addressed to a body of young men earnest in their desire to be somebody, to get to the head of their various professions. But if addressed to any other body of men it would have been equally applicable.

It was a spur to ambition, a talk to show that aimless work would bring men nowhere, that drifting with the tide would never land them on the high places.

Every man must work out his own salvation, must pick out his own goal and then strive on toward that goal; must have his wish and get wisdom to help him find the way.

In your profession this holds good as well as in any other. Ignorance in your profession means money-loss to your employers—knowledge in your profession and constantly adding to that knowledge means money-saving, better results; compels recognition of ability, and means progress toward your goal.

Wisdom in your profession means knowing how to do certain things better than the average run of engineers—knowing how to make one shovelful of coal do what two used to do; how to produce power at the very lowest cost.

And how better can you secure that kind of knowledge than by keeping yourself constantly informed as to the development made in the devices or apparatus needed in the power plant?

And how better keep yourself in touch with these developments than by reading the advertising of concerns making the devices you need in your work?

These concerns spend thousands of dollars for machinery and equipment to manufacture power plant apparatus.

And their product *must* be helpful *to you*, for their business success depends entirely upon how much better results their product enables the engineer to secure.

Consequently the arguments they advance are well worth careful study.

In fact to advance in your profession it is essential that you know what the manufacturers in your field are doing.

For they make the tools with which you must cut out your path to success.

If the ex-lieutenant governor had been addressing you, or a gathering of engineers, his advice would probably have been: "Have then thy wish and the Selling Section of your technical paper will help you find the way."

Taft Signs San Francisco Exposition Bill

On February 15, President Taft signed the bill designating San Francisco as the city in which will be held in 1915 the exposition signalizing the completion of the Panama canal. With a pen, the gold of which was mined in the State of California, and in the presence of two United States senators and a number of the representatives from that State, the President attached his signature. Mr. Taft presented the pen to one of the members of the party and it will be placed on exhibition at the exposition.

BUSINESS ITEMS

The Vilter Manufacturing Company, 854-894 Clinton street, Milwaukee, Wis., reports receiving recent contracts for three Corliss engines, sixteen refrigerating and ice plants; also a number of orders for ammonia piping, ammonia condensers, ammonia regenerators, etc.

The Rio de Janeiro Tramway Light and Power Company, Rio de Janeiro, South America, has placed an order with the Westinghouse Electric and Manufacturing Company for two 2500-kva., 3000-r.p.m. 6300-volt, three-phase, 50-cycle turbo-generators. The Westinghouse Machine Company will furnish the turbines, which will be equipped with No. 11 Leblanc condensers. This equipment will be placed in a new station which will operate in connection with the power company's water-power station. The station will be located in the city and will be used only when the water is low and the water-power plant cannot deliver its full rated capacity.

The C. & G. Cooper Company has been awarded contract by the Republic Iron and Steel Company, covering a 3000-horsepower cross-compound Cooper Corliss engine to drive its new Morgan continuous merchant mills, to be installed at Youngstown, Ohio. The engine will be direct connected to the mills by means of steel return cranks. This engine is practically a duplicate of a Cooper engine of this type driving a mill at the International Harvester Company's South Deering works. An order has also been received by the C. & G. Cooper Company from the Carnegie Technical Schools for a 75-horsepower Corliss engine to be installed in the mechanical-engineering department for testing and other experimental purposes in connection with courses of instruction in steam and mechanical engineering. This engine will be equipped with a combination rope flywheel, the face of which will be grooved for seven 1-inch ropes. A brake wheel will also be mounted on the main shaft for power measurements and regulation tests. The engine will be built to run 150 revolutions per minute.

NEW EQUIPMENT

Olney, Tex., voted $10,000 bonds for waterworks.

McComb, Miss., will construct an electric-light plant.

Chas. C. Chase, Haverhill, Mass., will install a boiler.

A. Olsen, Gold Hill, Ore., will build a $10,000 ice plant.

Dundas, Ont., will install complete hydroelectric machinery.

The Copley Trust Company, Boston, Mass, will install boilers.

Redlands, Cal., is planning the installation of a municipal water system.

Polytechnic, Tex., will vote on bond issue of $50,000 for water system.

The Clinton (Ky.) Water and Light Company will establish an ice plant.

The Lexington Hotel, Richmond, Va., will install a new refrigerating system.

The London (Ont.) Street Railway Company will install a new steam plant.

The Lonsdale Company, Pawtucket, R. I., will install new power-house equipment.

The Schriehart Brewing Company, Manitowoc, Wis., will build a new engine room.

Baraboo, Wis., is considering the erection of a municipal electric-light and power plant.

Fred N. Cross has been granted franchise for an electric plant at Central City, Iowa.

The Rhode Island Coöperative Coal Company, Providence, R. I., will install a boiler.

The Sprague Company, Pierce City, Idaho, is planning the erection of a hydroelectric plant.

The Pierce Power Company, Pierce City, Idaho, is planning the erection of a power plant.

Brownsville, Tenn., will vote on issuance of $35,000 bonds for extending its waterworks.

Newport, Tenn., will vote on issuance of $50,000 bonds for waterworks and sewer system.

The Perry (Fla.) Electric Company contemplates installation of a 15-ton refrigerating plant.

Eufaula, Ala., has engaged an engineer to estimate the cost of constructing an electric-light plant.

Bay City, Mich., will vote on the question of issuing $600,000 bonds for a modern waterworks plant.

The Chapin (Tex.) Motor Car Company will install a small electric-light plant in the near future.

The board of public works, Seattle, Wash., will install a refrigerating plant in the municipal building.

The Arkansas Cold Storage Company, Little Rock, Ark., is having plans prepared for a cold-storage plant.

Sentinel, Okla., will vote on issuance of $12,000 bonds for the construction of an electric-light system.

H. Van Allen, Redmond, Ore., is at the head of a company to erect an ice-making and cold-storage plant.

The Indianapolis (Ind.) Brewing Company will make improvements in its power plant to cost about $10,000.

The Waterville (Me.) & Fairfield Railway and Light Company will purchase a 400-kilowatt turbogenerator.

The Pacific Power and Light Company, of Portland, Ore., will build a $500,000 power house at Pasco, Wash.

The Shenandoah (Iowa) Light, Power and Heat Company expects to erect a new $12,000 ice plant in the spring.

The Chickasha Cotton Oil Company, Hollis, Okla., contemplates the erection of an electric-light and ice plant.

The Capital Traction Company, Washington, D. C., will erect a $200,000 power house at 3140 K street, N.W.

The Russellville (Ark.) Water and Light Company contemplates the erection of an auxiliary steam power plant.

The Hammerschlag Manufacturing Company, Garfield, N. J., will install a new gas engine in its power plant.

The Peoples Packing Company, Cleveland, Ohio, is building a new tank house and an addition to its boiler plant.

The De Laval Steam Turbine Company, Trenton, N. J., will be in the market for two 250-horsepower tubular boilers.

The Great Western Power Company, of Oroville, Cal., will spend $200,000 on improvements at its plant in Big Bend.

The Schwarzenbach-Huber Company, West Hoboken, N. J., will install a new engine and boiler in its plant on Oak street.

The Grays Harbor Railway and Light Company, Aberdeen, Wash., is making plans to increase the capacity of its power plant.

The Southern California Gas Company, Los Angeles, Cal., will install a gas-works system at Glendale, at a cost of about $50,000.

The New England Canning Company, Eastport, Me., is in the market for a direct-connected generator for lighting purposes.

The gas-generating plant of the Boston & Maine Railroad, at East Deerfield, Mass., was destroyed by an explosion. Loss, $25,000.

The Waco (Tex.) Gas Company is erecting an addition. Will install larger steam turbine, also new surface condenser, boiler and stoker.

The Olympia Brewing Company, Pasco, Wash., is having plans made for refrigerating plant and cold-storage warehouses, at Pasco, Olympia and Hoquaim.

The Tidewater Power Company, Wilmington, N. C., will be in the market for a boiler, a 500-kilowatt rotary converter, two 200-kilowatt transformers.

The Weimer (Tex.) Ice and Cold Storage Company has been organized with $12,000 capital to install an ice and cold-storage plant. Chas. Fahrenthold, president.

The Pacific Gas and Electric Company, Sacramento, Cal., will build a 15,000-horsepower steam plant to cost about $500,000. Will also make extensive additions to its gas plant.

The Boston & Maine Railroad is planning the erection of a power plant at the foot of Mt. Washington, as it intends to electrify the section of the railroad which goes to the summit.

The Humboldt Irrigation and Water Power Company, Lovelock, Nev., will be in the market for a 150-horsepower gas engine; also generator, transformer, switchboard. S. R. Young, manager.

The director of public service, Cleveland, Ohio, has been authorized to make purchases for the water department, including valves, hydrants, lead pipe, lubricants, etc., and for lighting plant, electric meter, transformers, arc lamps, etc.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ENGINEERS WANTED to solicit for the Rolin patent adjustable grate. Apply Standard Grate Co., Heed Bldg., Philadelphia.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

SALES AGENTS to sell steam turbine blowers, feed water regulators, ventilating fans, pumps, etc.; guaranteed territory; commission. Wing, 90 West St., New York City.

ENGINEERS wanted in every town to sell Wiechmann tube cleaners for water and fire

tube boilers; perfection in the art; attractive proposition. Clyde Machine Works Co., Chicago, Ill.

WANTED—Thoroughly competent turbo-electric power station engineer; must also have thorough operating knowledge of high duty Corliss pumping engines; salary $150 per month. Box 391, POWER.

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

SUBSTANTIAL mining company in Mexico require the services of an A-1 experienced master mechanic, thoroughly up in electrical and mechanical engineering, and mining and milling machinery in general; give full particulars and references; salary $200. Address "L. T. C.," Box 374, POWER.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

DRAFTSMAN—Turbine, engine and some boiler experience; shop and erecting experience. Box 389, POWER.

WANTED—Position by young married man, familiar with a.c. and d.c. in parallel and all makes of engines and boilers; references. Box 380, POWER.

POSITION WANTED by engineer, twelve years' experience, understands electricity, ice machines and gasolene motors; age 29, married; speaks Spanish. Box 462, Warren, Ark.

CHIEF ENGINEER—Years of experience with high-pressure superheated steam, steam turbines; experience in erection of steam plants; as to salary try me first, if I don't make good, don't pay. Box 392, POWER.

MECHANICAL ENGINEER; competent designer, mechanical, electrical and construction work; broad experience development and design of industrial plants; technically educated; age 26. Address Box 386, POWER.

MECHANICAL SUPERINTENDENT, 20 years' experience in textile manufacturing, cotton goods, print works, dye works and bleaching; capable of taking full charge of mechanical and electrical departments, also construction. Box 390, POWER.

WANTED—Situation as chief engineer; New York license; good mechanic and can make all repairs; twelve years' marine and stationary experience; can furnish best references from present and past employers. Address "A. S. P.," Box 393, POWER.

YOUNG TECHNICALLY EDUCATED engineer (M. E.-E. E.), experienced in railway and central station design, construction, operation and business methods, desires position of responsibility; energetic; best references; any location. Address Box 384, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—A $130 scholarship with International Correspondence Schools; will sacrifice for cash. E. F. Banette, St. Albans, Vt.

FOR SALE—Two 1-inch hot water test meters, Worthington plunger type; body all brass; in perfect order. W. H. Odell, M. E., Yonkers, N. Y.

FOR SALE—Small screw cutting lathe, chuck and tools; fine condition; bargain. South Bend Machine Co., 424 Madison St., South Bend, Ind.

FOR SALE—Electric light plant in growing Nebraska town, pumping city water, new 20-year franchise and street-lighting contract. Box 381, POWER.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—32-horsepower and 14-horsepower Backus gas engines, line shaft and other equipment, Bliss No. 30½ combination back geared and direct drive punch press; all of the above machines in the best of condition; can be seen at any time. Ellis Adding Typewriter Co., 204 Morris Ave., Newark, N. J.

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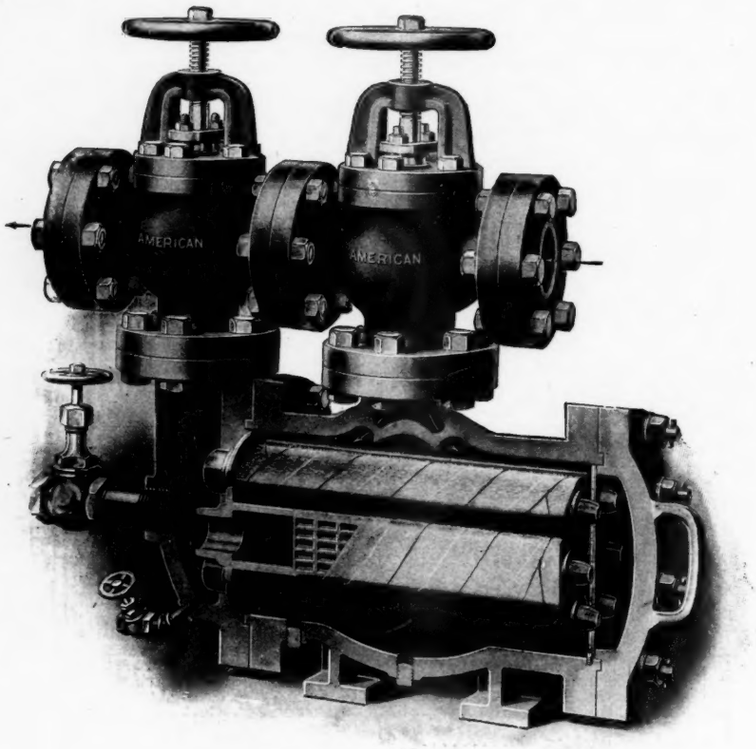
The American H_2O Grease Extracting Feed Water Filter



In every plant where condensation is used for boiler feed this practical device should be installed.

Because it accomplishes complete removal of oil or grease from the condensation before it enters the boiler. In this way it prevents all possible chance of bagging boiler plates or tubes due to oil caking on the metal.

It reduces boiler repairs, makes it easier to keep up steam, increases boiler efficiency.

If you use condensation for boiler feed, put in one of these filters and prevent all chance of oil or grease getting inside the boiler.

Complete details of this and our other specialties on request.

Some Features

1. It has a filtering surface equal to 320 times the area of the feed water pipes — a greater area than ever before obtained.

This feature assures positive filtration at all times and under all conditions.

2. It has few parts and each part is easy to get at.

Renewals and changes can be made quickly and with ease.

3. It has a device for applying a reverse current of steam for temporary cleaning.
4. The whole construction is along the most simple lines, making for great efficiency and long life.

American Steam Gauge & Valve Mfg. Company

New York Chicago Boston, Mass. Pittsburg Atlanta

The Engineer Who Owns An American-Thompson Indicator Knows That No Other Engineer Has As Good An Instrument As His

Excepting Another Owner of an American-Thompson

In construction and quality of service it is the best of its kind—the recognized standard the world over.

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And, remember, it's the long run service that counts—you don't buy an indicator for short time service.

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Yet the terms on which you can buy this Quality indicator are easy—$5.00 down, $5.00 monthly. And your American-Thompson itself will help you pay the installments. The complete price is $55.00.

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$5.00 Down—$5.00 Monthly

All element of risk is removed from the purchase, too, because we give every buyer the privilege of examining his outfit five days; if it isn't completely satisfactory the $5.00 first payment will be refunded without question.

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Mail Coupon if you desire further details

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New York Chicago Boston, Mass. Pittsburg Atlanta

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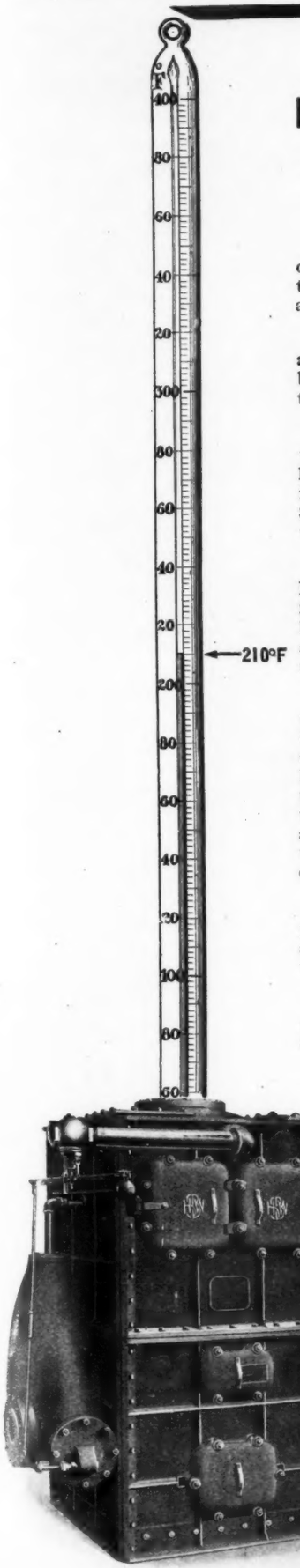
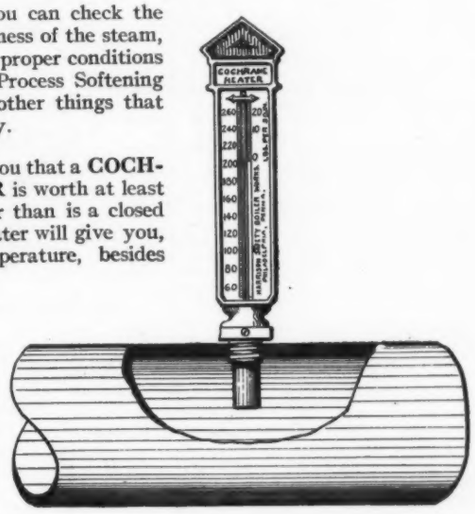


How Hot Is Your Boiler Feed Water?
Every 10°F. = 1% Of Fuel

In the majority of all steam plants, a good thermometer is worth more to the owner or operator of the plant; that is, will result in the saving of more money than the steam engine indicator, and this conceding that the indicator is indispensable

When it is considered that **every 10° F. which can be added to the temperature of the boiler feed supply means from 1% to 1.2% of the entire fuel bill,** it will become at once apparent that engineers and owners ought to have thermometer "indicators" at various stations in their steam power plant.

With a good thermometer you can check the vacuum gauge, determine the dryness of the steam, know whether you are getting the proper conditions for chemical reactions in a Hot Process Softening System, and determine a dozen other things that vitally affect steam plant economy.

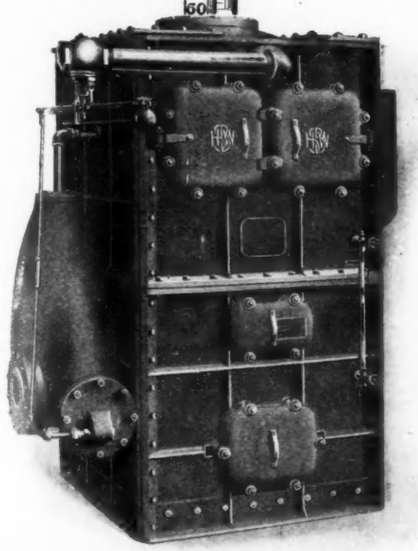


A thermometer will prove to you that a **COCHRANE FEED WATER HEATER** is worth at least $50 more per 100 H.P. per year than is a closed heater, that is, the Cochrane Heater will give you, and constantly, the higher temperature, besides real purification

A thermometer will show the value of the Cochrane Oil Separator for purifying exhaust steam before it passes to the heating or drying system, so that the warm condensed returns may be used for boiler feed at 120° to 150° F., instead of cold water at 60° F. Here again each 10° F. is 1% of the fuel bill.

A thermometer will enable you to determine accurately what back pressure you are carrying in the heating system, and to vary this back pressure, if need be, and you have the right kind of back pressure valve, to accommodate changes in the weather.

So important do we consider a thermometer to the proper appreciation of the superior value of Cochrane Steam and Oil Separators, Cochrane Feed Water Heaters, Cochrane Feed Water Heaters and Receivers, and Sorge-Cochrane Hot Process Water Softening Systems, that, for a limited time, we will sell thermometers at special prices to operating engineers complying with the conditions of the attached coupon.



Harrison Safety Boiler Works,
17th & Clearfield Sts., Philadelphia, Penna.

(*Tear off here and mail.*)

Enclosed herewith please find $1.50 for which please send me one Cochrane Hot Water Thermometer. The regular price is $3.00 to $3.50. Prices of other grades and of pocket thermometers upon application.

In consideration of the reduced price at which this thermometer is sold to me, I agree to insert the same in the boiler feed supply line from our . . . . . Feed Water Heater (*Make and type must be stated*) and to report to the **Harrison Safety Boiler Works** the readings for each hour during an average day's operation of the plant.

NAME . . . . . .

POSITION . . . . . .

FIRM . . . . . .

ADDRESS . . . . . .

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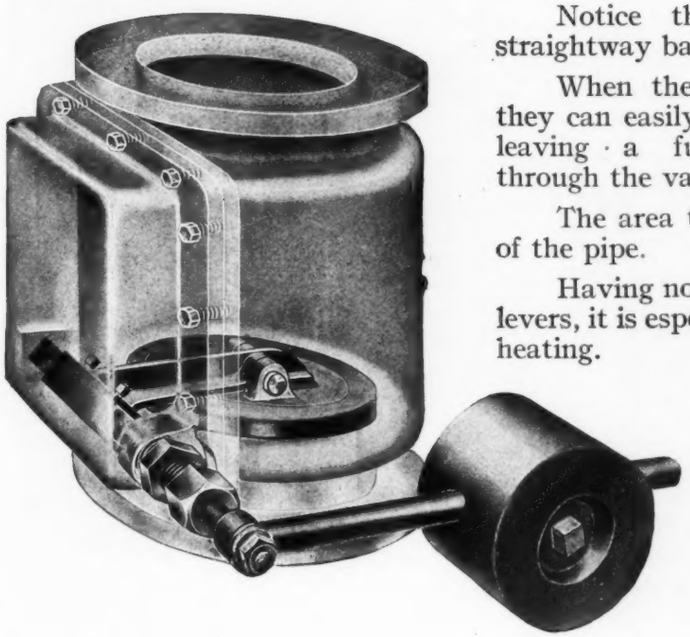
Excelsior Straightway Back Pressure Valves



Notice the ideal construction of this straightway back-pressure valve.

When the working parts are not needed they can easily be thrown back into the cover, leaving a full-sized unobstructed passage through the valve.

The area through the seat is equal to that of the pipe.

Having no dashpots, guides, or complicated levers, it is especially valuable for exhaust steam heating.

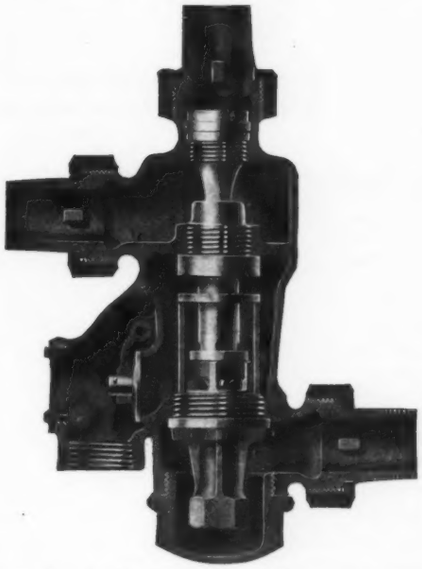
Can be used in a vertical or horizontal position or at any desired angle. It is also well suited for use as a relief or free exhaust valve for condensing engines and when required can be supplied with body arranged for water seal; in this case, however, it can be used only in a vertical position.

Sellers Restarting Injector

Absolute dependability in operation is an important feature of this injector. The materials and workmanship are of the highest order, the heavy castings for the tubes are of the best steam metal, the whole construction makes for great strength and durability.

The joints are screwed and the tubes do not depend on the pressure of steam to hold them in place; no leakage at the shoulder can consequently take place.

It has a wide range of capacities and lifts the water promptly with hot or cold pipes. Furthermore, it restarts instantly after a temporary interruption of the steam or water supply.



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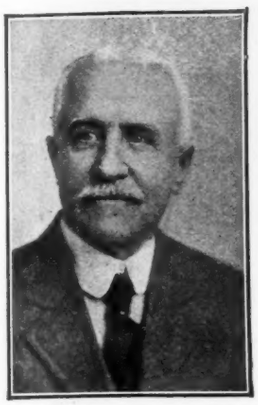
The "Eureka" Square Deal

Published every other week in the Interests of Honesty in the Packing Business.

Vol. I. **By James L. Robertson.** No. III

What do you think of the "Graft" Salesman?



JAMES L. ROBERTSON

Suppose you were a packing salesman; wouldn't you hate to take a job where every time you went in to make a sale, you'd have to beat around the bush to find out if the buyer would take a bribe?

Wouldn't you hate to back and fill, hem and haw, shuffle and sidestep, and finally sink your self-respect and dignity and honesty to make a few dollars? Is that salesmanship?

What class of salesmen do you think will take that kind of a job? Is he a man you would place full confidence in?

Good salesmen want to sell good goods purely on merit and by conviction, without fear of any come back from the boss.

Good buyers want to buy that way—no *progressing* engineer ever buys on any other basis.

No wise engineer jeopardizes his present and future by *selling* himself to a bribing packing salesman.

I'm looking for some one of these salesmen or their principals who will come out into the lime-light and put up a defense for his practices. I expect to keep on looking for some few days longer, thank you.

Is it honest to offer or accept a bribe? **No!**

Is it good morals? **No!**

Is it good business? No!

Is it square and fair? No!

Is it good engineering ethics? No!

Is it harmful to the buyer?

Yes, in the long run the buyer will be the real sufferer.

For a great many years I have made and sold "Eureka" Packing solely on its merits, and, with the exception of the New York city district, wholly through dealers.

Eureka carries with it less profit for the maker and the dealer than any other packing I know of.

When a dealer offers it to you he does so because he knows that it will make you a satisfied customer of his.

Eureka never has nor ever shall depend upon a bribe to sell it.

I, in common with other straight packing makers, believe in doing business out in the open on a fair and square basis—the other people can get into the dark corners to conduct their transactions.

I want to do business with and sell Eureka to the fair and square engineers of the country. They will give me all the business I can handle, for they make up the great majority of their honorable profession.

I'd like to have *your* opinion on the whole subject.

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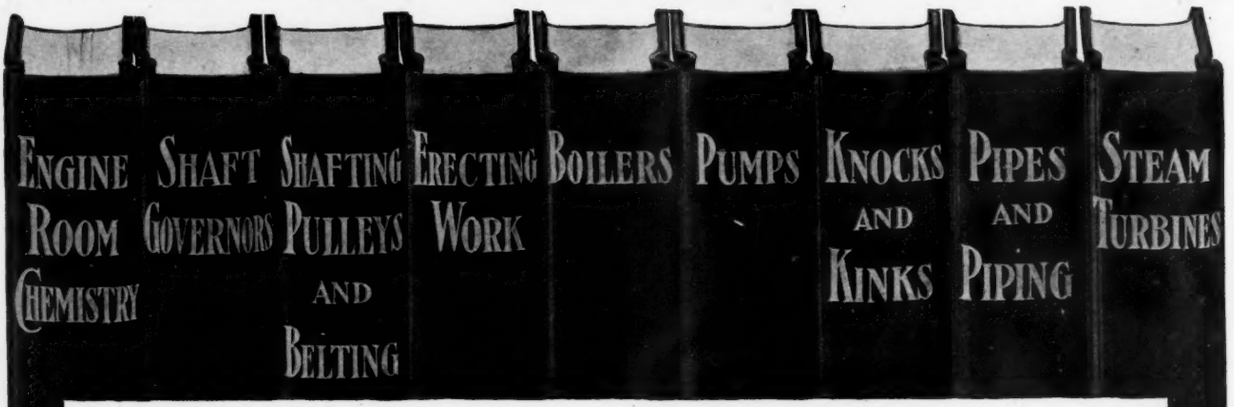

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